How does environmental capability develop in a firm?: A case analysis combining resource-based and institutional perspectives

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How Does Environmental Capability Develop In A Firm?: A Case Analysis Combining Resource-Based and Institutional Perspectives

submitted by Anna Ruth Thomas
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Summary

Extant studies of environmental capability have focused predominantly on examples of best practice and the contributions of specific capabilities to competitive advantage outcomes. This thesis makes the case for understanding the development and application of environmental capability from a broader perspective that includes consideration of existing business strategies and available resources. I argue that, to explain the evolution of environmental capability more fully, it is necessary to disaggregate this concept to a series of identified 'resource characteristics' which may be empirically investigated. In addition I suggest that, selected factors both internal to the firm and in the immediate organisational environment, may act to moderate the development process.

To pursue these propositions, I analyse how one organisation has approached the challenges and opportunities presented by environmental concerns in both its operating and market environments. In particular, I focus on the development of the organisation's environmental management programme and track the innovation paths of three new environmental projects. I collected data using a pragmatic methodological perspective and in doing so employ mixed methods.

The analysis points to a more complex picture of environmental capability development, than has been previously expressed in the literature. In this case, I identify that the key building blocks of the environmental capabilities investigated vary both in strength and form. Further, three potential moderating factors, the organisation's non-environmental strategies, track record on environmental issues, and experience with innovation, are shown to significantly influence capability evolution. The analysis also serves to illuminate the importance of taking organisational context into consideration.

This thesis provides empirical support for arguments which suggest that research needs to link the greening process in firms with organisational theory. I contribute to the literature on environmental management and strategy by building explanations for the development of environmental capability that combine resource-based with institutional perspectives.

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Chapter One: Introduction

1.1 Introduction

Concern for the environment has risen steadily over the last 30 years. This period of growing awareness has been marked by significant milestones that include the first United Nations Conference on the Environment in 1972, the 1987 World Commission on Environment and Development (The Bruntland report), and the Rio Earth Summit in 1992. In response, environmental issues have progressively become institutionalised in our regulatory and political structures. The role of business has, however, been less clearly defined. During this time, industry has been framed both as the culprit responsible for environmental damage and also as a potentially powerful agent for positive environmental change. Important, therefore, has been the need to gain an understanding of how business perspectives are changing and what actions are being taken by firms to address the environmental agenda.

Investigation of the academic literature reveals that environmental issues have progressively expanded beyond the level of niche interest in a range of disciplines. Yet research also shows that the relationship between organisations and the natural environment had, until the 1990s, suffered a dearth of empirical investigation (Starik and Marcus, 2000). However, the emergence of 'environment as opportunity' and the growth of a more inclusive, sustainable development perspective, has progressively heightened an awareness of the need for more extensive and rigorous research in this field.

This study was undertaken during a period of significant growth and change in the development of environmental management and strategy. Previous accusations that management scholars have neglected environmental issues (Gladwin, 1993) need now be tempered as increasingly mainstream business perspectives are applied to the interactions between organisations and the issues raised by the environmental agenda. Crucially for the debate and the analysis which follows, researchers have actively begun to pursue the application of a range of existing organisation theories and strategic perspectives in order that we might understand more fully the processes and outcomes of change. This thesis contributes incrementally to the establishment of environmental management as an important facet of the literature on organisations and business. It does so by working at the intersection of resource-based and institutional views, but

also draws on insights from the broader literature on environmental innovation and management.

The following introductory discussion is divided into two main sections. In the first section I provide a brief analysis of the key concepts that generated the questions guiding the thesis. This focused introduction serves as a precursor to the detailed analysis of the extant literature that follows in chapter two. In the second section I outline the document structure and highlight the relationship between the chapters (illustrated in Figure 1.1). This section also summarises the main messages and themes contained in each chapter. The chapter concludes with a brief summary of the main points covered.

1.2 Background

During the early 1990s a significant volume of research was dedicated to detailing why companies should adopt environmental management strategies as well as prescribing the methods and practices they should employ in order to do so (Welford, 1996; Stead and Stead, 1996). Additionally, a number of influential writers introduced and popularised the notion of 'win-win' where firms may succeed in achieving competitive advantages through the application of a range of environmentally progressive measures such as, reducing scarce or toxic resource use and re-engineering technologies to recycle and reduce waste products (Porter, 1991). In practice, however, this proactive stance was not necessarily an easy or commercially attractive proposition for many firms and as a result there followed a substantial back-lash with authors critiquing the foundations of the 'win-win' populists (Walley and Whitehead, 1994).

What was required in the literature was a more detailed and empirically based understanding of the rationale for firm choice. In her thesis and subsequent work Bansal (1995, 1997, 2000) synthesised three broad reasons why companies might chose to adopt environmentally progressive measures. They are:

1. To gain strategic advantage (synonymous with the notion of 'win-win') through for example, supply chain management, lowering product costs, green marketing or employing total quality environmental management;

2. To act responsibly (driven by social and ethical concerns) by employing ethical policies, social auditing and partnership approaches;
3. To avoid strategic disadvantage (associated with managing risk and reputation) by reducing environmental impacts, seeking accreditation and building networks (Bansal, 1997).

Reviews of the literature suggest that a large proportion of empirical research has focused on the first two reasons indicated above. There has been extensive work conducted with respect to firms such as 3M, whose 'pollution prevention pays' programmes have been a source of competitive advantage (Shrivastava, 1995). The literature has also expanded significantly to address the practical requirements and strategic challenges facing companies driven by socially responsible motives (McIntosh et al, 1998). Whilst a substantial level of work has been committed to the development and implementation of accredited standards (Sunderland, 1997) noticeably less attention has been given to the broader elements of Bansal's (1997) third reason why firms may engage with environmental practices, avoiding strategic disadvantage. This is perhaps because this risk avoidance option is the strategically least dynamic, and as such may hold intrinsically less interest for environmental strategy researchers.

Investigating firms that pursue risk avoidance rather than competitive advantage or social responsibility is however, key to understanding the processes associated with the management of change in an environmental context. This is because it involves looking more closely at the 'trade-off zone' where the balance between environmental benefits and costs is less clear cut (Walley and Whitehead, 1994). Significantly, this category relates most closely to firm survival (for example where changing legislation demands that a particular accreditation is necessary in order to protect a firm's licence to operate) and is, as Bansal indicates, strongly influenced by the need to achieve and sustain 'organisational legitimacy'. Crucial here, is a recognition that avoiding disadvantage is itself a strategic option and as such it demands that companies must make *some sort of change* to remain viable in this new business climate.

In her analysis Bansal (1997) suggests that a combination of substantive (reducing environmental impact, risk management), symbolic (accreditation, language change) and enacted (building networks, education and information) changes may be necessary

to maintain legitimacy. In situating this position of organisational legitimacy between corporate 'self interest' and 'altruism', Bansal (1995) leaves unexplored the detail relating to *how* firms may actually go about developing and implementing environmentally progressive measures that reduce the firm's exposure to risk. Significantly though, the theoretical overlaps of this position suggest that there may be opportunities to inform the analysis of how firms make this progression by drawing on the competitive strategy and institutional literatures.

In this study, I draw on the theoretical complementarity alluded to here, and point to the possibility that capabilities concepts, usually associated with competitive strategies, could also be intrinsic to understanding the changes that are necessary in the context of a survival strategy. Moreover, in order to understand how change takes place in this context, I suggest that we need to specifically address the development of key *environmental capabilities*. Therefore, the central theme explored in this thesis is:

- *How does environmental capability develop in a firm?*

To address this theme I consider:

- *What are the necessary building blocks for the development of appropriate environmental capabilities?*
- *To what extent is this development process influenced both by other factors internal to the firm and by immediate organisational context?*

In chapter three I refine and focus these themes through a series of research propositions that guide the data collection and frame the subsequent analysis.

The need to consider the existence of environmental capabilities and their development from a broader perspective and in relation to a range of outcomes, has recently been supported by Christmann (2000) whose analysis suggests that:

> "Future research needs to analyse environmental strategies in the broader context of firm's existing resources and capabilities and their existing business strategies. Studies should also analyse the environmental practices and the resources and capabilities of firms that fail to gain competitive advantage from their environmental strategies." (Christmann 2000, p. 675)

This study, therefore, sets out to pursue an identified weakness in the extant literature. It does not seek to answer the 'why' questions associated with 'greening', as they have already been extensively investigated in the recent environmental literature. Rather, I focus in on the question of 'how' change takes place in a context where (as will be demonstrated) strategic aspirations are more closely associated with survival than competitive advantage or social responsibility. As such the aims of this study are to investigate process (in terms of what is actually happening inside the organisation) as opposed to intention.

In order to do this I provide a rich analysis of one organisation's experiences, which reflects the difficulties and the successes of this development process. Specifically, the study focuses on the environmental activities of English China Clays International (ECC) which is now part of the Paris based minerals and metals processing company Imerys. ECC commands a unique position both within the UK as the country's biggest exporter of minerals, and regionally as a direct contributor of £120M to the Cornish economy. The nature of raw material extraction and processing activities, mean that ECC faces a range of environmental pressures and challenges in both its operating and market environments. These issues, which are discussed in detail in chapter five, form the background for this analysis.

In addition the company's endeavours to advance its environmental position from compliance towards performance improvement, make it an ideal arena for exploring the development of environmentally progressive measures. Some of the findings of this study aim to contribute at a theoretical level and as such may have generic applicability for the development of environmental capability in extractive companies. Other contributions derive from the specific historical background and contemporary circumstances at ECC, and are therefore particular to this case.

1.3 Document Structure

The first section of this chapter has provided a brief introduction to the thesis by outlining the key drivers behind the central research theme. This section discusses the links between the subsequent chapters illustrated in Figure 1.1 below.

Chapter two takes forward these themes and concepts in a detailed analysis that charts a path through the extant literature in order to identify opportunities for research in the area of environmental capability. Specifically, this chapter identifies the value of grounding this work in the resource-based view of strategy and illustrates how applying this perspective in an environmental context may provide new directions for the environmental management and strategy literature. The chapter concludes by highlighting theoretical and methodological gaps in the environmental capability literature.

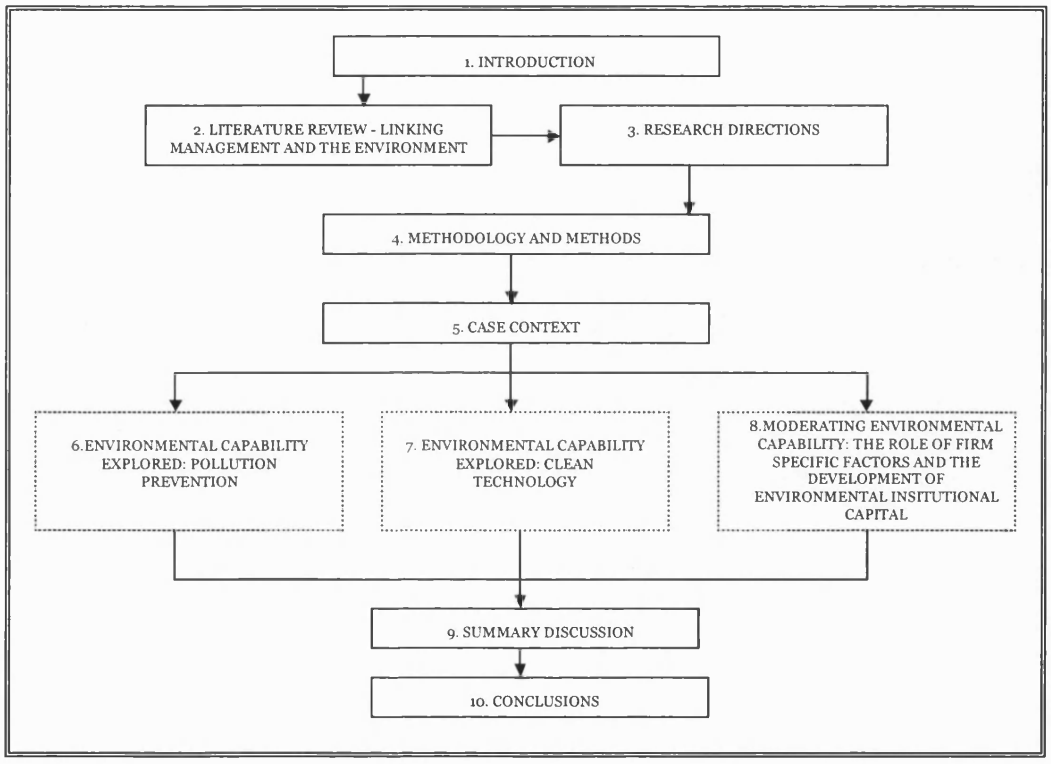

Figure 1.1: Document Overview

Chapter three introduces and makes the case for the specific research context. The analysis then develops the key areas identified in chapter two and in particular, disaggregates previous conceptions of environmental capability to the level of 'resource characteristics' that may be empirically investigated. In this chapter I also develop the concept of moderating variables and introduce two elements of environmental institutional capital, thereby drawing on institutional perspectives to broaden the conceptual basis for the thesis. Four sets of propositions, designed to focus the

empirical investigation, are summarised at the end of the chapter and the concepts guiding the study are outlined in an illustrative framework (Figure 3.2).

Chapter four discusses the methodological choices and preferences that direct the study. In this chapter I describe the rationale for choosing a pragmatic approach to my research, which is situated between the post positivist and constructivist paradigms. Guided by this philosophy I argue that the aims of the study are best served by a case study strategy using embedded units, which allows for a sub-organisational perspective necessary for the concepts being investigated. In adopting this approach, I employ mixed methods to gather the empirical data and discuss the issues associated with method choice and data analysis.

One of the key arguments in this thesis relates to the value of exploring and understanding the role of organisational context in the development of environmental capability. Chapter five provides a broad and necessarily descriptive overview of the case company. It is not an exhaustive exposition and as such focuses on those areas considered to be the most relevant to the issues explored in this case. This includes key historical events, contemporary organisational change, environmental issues in the company's main markets, and significant environmental concerns associated with the company's operating environment.

Chapters six, seven and eight present and analyse the empirical data gathered during the study. The analysis is structured according to the propositions developed in chapter three. In chapter six, I breakdown the five resource characteristics proposed as underlying a pollution prevention capability. The analysis is framed by the organisation's environmental management programme. The extent to which the resource characteristics are considered to be established in the organisation, is discussed through key themes as they emerge from the data. This chapter draws evidence from both the qualitative and quantitative elements of the study.

In chapter seven I explore the resource characteristics proposed as underlying a clean technology capability. The analysis in this chapter is framed by the organisation's research and development work on several environmental projects. To assist the

analysis I draw on a range of sources including observation and secondary data to present 'project briefs' of the innovation work examined.

Chapter eight considers the final two sets of propositions which address the role of three identified, potential moderators and two selected areas of environmental institutional capital. As in previous chapters the data is presented according to emergent themes. The chapter draws primarily on the qualitative interview material, but also employs key 'exemplars' which illustrate important themes in the analysis. To maintain continuity, each of the data chapters contain detailed summaries that draw together the evidence presented.

In chapter nine I reflect on the central research theme by summarising the key findings as they relate to the four sets of propositions. The discussion considers the value of both the underlying concepts driving the propositions and the empirical data itself. I argue that the disaggregated approach employed has assisted our understanding of the development of environmental capability, but that any findings need to take account of the limitations inherent in the research strategy.

Chapter ten outlines the main contributions of this thesis which fall into five main areas. They are:

1. *The disaggregation of environmental capability.* This thesis demonstrates the value of considering the underlying 'resource characteristics' of environmental capability;

2. *The influence of moderators.* The study identifies and shows how other factors internal to the firm can influence the development of environmental capability;

3. *The incorporation of organisational context.* The case analysis illustrates how selected elements of environmental institutional capital, can either support or detract from the development of environmental capability;

4. *The identification of 'negative' resources.* The thesis findings point to the need to consider how some resources can inhibit the development of environmentally progressive measures;

5. *The use of sub-organisational analysis.* The work fills an identified empirical gap in the analysis of environmental capability development.

In this chapter I also explain the limitations of the findings as they relate to the theoretical and methodological choices made throughout the study. The discussion concludes with a view forward to the future research opportunities based on the thesis' findings.

1.4 Chapter Summary

This chapter has introduced the guiding questions of this thesis which seek to determine how a firm undertakes the development of environmental capability in the context of a strategy that is largely legitimacy seeking. The discussion has alluded to the opportunities that may exist to explore the issues arising by working at the intersection between competitive strategies and institutional perspectives. The chapter has also described how the evidence and supporting arguments will be presented in this thesis. This process begins in the following chapter, which embarks on an analysis to refine those areas of the extant literature most relevant to this study.

Chapter Two: Linking Management and the Environment

2.1 Introduction

This chapter positions the thesis in the emerging arena of environmental management strategy. In doing so it draws on theoretical foundations developed in the more established fields of management strategy and organisation theory. The discussion is divided into four principal parts. The first briefly considers the nature of management strategy and then analyses in more detail, an emergent stream of literature developing around the resource-based view of the firm. A critique of this material is presented and opportunities for further research are highlighted.

Second, the emergence of environmental management strategy is considered in the context of the more broad-based, environmental business literature. Attention is given both to the arguably prescriptive nature of early environmental management writing, and to the subsequent calls for stronger theoretical foundations to underlie empirical investigations in an environmental context. The progression towards and results of, more rigorous environmental management research are reviewed and key contributions relevant to this discussion are highlighted. The third part (sections 2.9 and 2.10) discusses and illustrates how the debate has been strengthened through contributions from organisation theory and considers the potential complementarity of combining theoretical schools of thought.

The fourth part of the discussion (sections 2.11 and 2.12) focuses on an analysis of empirical contributions undertaken in an environmental context that draw their conceptual rationale from a resource-based perspective. The findings, omissions and potential contributions to this branch of the literature are critically examined. Consideration is given to how authors have interpreted the importance of organisational context and factors external to the firm, as 'moderators' in the development of organisational environmental capability. Lessons and examples are drawn from complementary theoretical schools in particular institutional perspectives, in order to provide a foundation for the research. In evaluating these contributions I point to areas where opportunities may exist for further research. It is these areas that form the basis of a series of research propositions, which I develop in chapter three.

The scope of the literature embraced by the critical review in this chapter, and in the subsequent development of the research propositions in chapter three, is summarised in Figure 2.1.

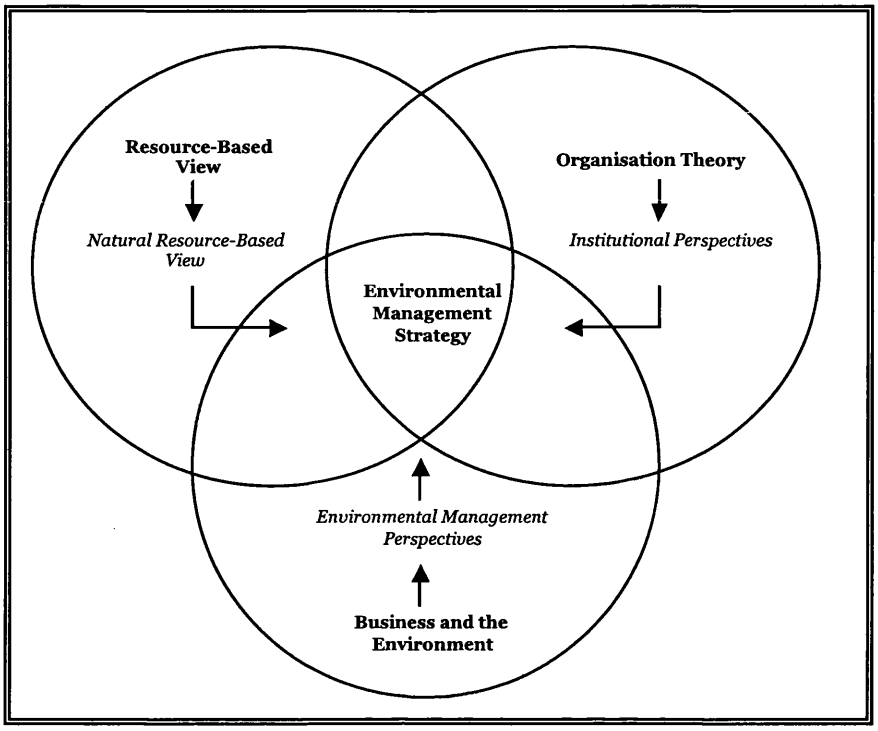

Figure 2.1: Literature Summary

Whilst authors have developed a series of perspectives on strategy (discussed briefly below), it is the influence of resource-based work that is primarily considered in this review. In particular, I focus on more recent studies that apply these concepts from an environmental perspective. I recognise, as Pugh (1997) notes, that organisation theory comprises a body of knowledge embracing perspectives on the structure, function and the performance of organisations as well as the behaviour of individuals and groups within them. In this study I draw on a range of organisation theory influences but focus predominantly on contributions that derive from institutional perspectives (see chapter three, section 3.6).

The business-environment literature has grown substantially since the 1980s and is gradually beginning to reflect a more connected and holistic approach that authors suggest will contribute to the 'greening' of management (McDonagh and Prothero, 1997). In this review and the development of the research propositions in chapter three,

I examine both conceptual and empirical contributions to the 'greening' of organisations. The analysis in this chapter is principally at an organisational level rather than at a detailed functional level as seen in the applied work on for example, the 'greening' of the supply chain (Lamming and Hampson, 1996) and 'green' marketing (Peattie, 1995). In chapter three I take a more focused perspective that necessarily draws on particular environmental management perspectives to support the research propositions (for example, work on environmental training and the development of environmental values in organisations).

2.2 Making Sense of Strategy

In the context of management writing environmental management strategy is a fledgling subject. As I shall observe in succeeding sections, environmental writing has adopted the tactics of a *bricoleur* in 'borrowing' from neighbouring disciplines. As a consequence, organising frameworks have tended to lack the unifying themes required for clarity. This confusion has been little remedied by a strong reliance on the field of strategic management. The following section looks briefly at some of the key elements that characterise the field of strategy.

Strategy has developed into one of the most important and yet, in many ways, one of the most controversial aspects of management research. As Micklethwait and Wooldridge (1997) observe, [it] has become a somewhat 'obtuse art' caught midway between the regimented planning of the 1950s and the ever more visionary approaches characteristic of the 1990s. The growth of critical approaches to strategy, in particular those that challenge the predominance of rationalist thinking through the inclusion of 'interests' (Knights and Morgan, 1991), have also served to open and broaden discussion in the field.

Reviews of the literature suggest that there is no one 'theory' of strategy and the subject is rich with jargon, models and tools. Influences have been drawn from military practice and futures research as well as business management (Evered, 1983). Each discipline has its own ways of conceptualising and talking about strategy. In business writing,

while there are some general areas of agreement[1] (Chaffee, 1983) it is hard to discern an 'essence' of strategy (Jones, 1998). Not surprisingly, definitions of strategy vary depending on perspective and authors have rarely agreed on an overarching version (Chandler, 1962; Ansoff, 1965; Andrews, 1987; Moore 1992; Mintzberg et al, 1988). This as Hambrick (1980) suggests, relates to the multidimensional and situational nature of strategy, which has affected the ways in which authors operationalise the concept. The result, is a body of work that varies both in terms of what authors understand strategy to be about, and importantly, where in the organisation these ideas are best applied.

Although no single 'strategy framework' exists, it is possible to discern themes that link the work of different writers. Over time, strategy has been viewed as occurring at different levels in organisations and as ranging in its scope and objectives (Hofer and Schendel, 1986; Digman, 1990). Some authors, stimulated by the original work of Andrews (1987), interpret strategy in a broad sense. In this conception, strategy is concerned with the mission, vision and guiding principles of the organisation, as well as the formulation of processes designed to realise those goals and objectives. Importantly, for subsequent work in this field, this wide interpretation introduced the idea that strategy should be about a consideration of the organisation as a whole. Following Andrews (1987) suggestion, the organisation is viewed as an open system, which functions and operates as an 'entirety', relating purposefully to the world around it. Strategy is therefore seen as an ongoing organisational activity that embraces elements of formulation, management of process, and the performing and implementation of strategic decisions in the pursuit of organisational goals. This broader view of strategy is, as Chaffee (1985) indicates, characterised by a linear approach where a series of

[1] Chaffee (1983) in her contemporarily applicable analysis of strategy models, identifies seven key points on which theorists appear to agree:

- the inseparability of organisation and the environment;
- the substance of strategy is unstructured, unprogrammed, non-routine and non-repetitive;
- strategic decisions affect the overall welfare of the organisation;
- the study of strategy includes the content of strategy and the processes by which actions are decided and implemented;
- intended, emergent and realised strategies may differ from one another;
- firms may have, corporate strategy (what business are we in?) and business strategy (how shall we compete in each business?);
- making strategy involves conceptual as well as analytical exercises (conceptual work is done by the leaders of the organisation).

sequential actions follow planning phases. This forecasting usually takes place at top management levels.

In contrast, authors such as Ansoff (1987) and Hofer and Schendel (1986) propose a narrower interpretation of strategy. In their conception, strategy is concerned with the fundamental 'means' an organisation will employ to achieve its objectives. They contend that goal setting and strategy formulation are in fact distinct processes (although they acknowledge that the two processes are intimately intertwined). The authors suggest that it is less confusing if each process is given a separate name (Moore, 1992). The development of organisational goals and objectives are therefore distinguished as being a different aspect of organisational activity which they term 'grand design' (Hofer and Schendel, 1986). This allows them to present the strategy concept more narrowly, as being the 'means' for achieving organisational visions. In doing so they break down strategy and present the concept as being composed of specific elements. These elements are defined as:

- *scope* - the extent of interaction between the organisation and the business environment;
- *resource deployment* – skills and resources that will contribute toward achieving organisational objectives;
- *competitive advantages* – developing unique patterns through resource deployment;
  synergy – the 'joint effects' or interactions between the first three factors (Moore, 1993, p. 221).

This narrower focus points to a more 'adaptive' interpretation of strategy that is characterised by the search for a strategic fit between the external environment and the organisations' capabilities and resources, for example, through cost leadership or differentiation (Chaffee, 1985; Porter, 1990). This work occurs in the business units where managers interface more closely with the market environment. Arguably, therefore, this conception of strategy is more closely associated with the pursuit and maintenance of competitive advantage.

Further development of the strategy concept has witnessed writers adopting positions on a continuum between these two perspectives by developing 'hierarchies' of strategy. Digman (1990) for example categorises strategy as existing at four different levels in any organisation:

- *Enterprise Strategy* – dealing with organisational vision, its purpose and role in society;
- *Corporate Strategy* – engaged with multi-business relationships;
- *Business Strategy* – concerned with the detail of how to compete most effectively;
- *Functional/ Operational Strategy* – dealing with specific aspects of the business such as finance or operations (Digman, 1990).

This suggests that while the debate about strategy has tended to be polarised by either holistic conceptions of the organisation (which include both its purpose and activities) or the more limited focus (that concentrates on strategy as a competitive tool) it also includes work that attempts to bridge the divides.

I noted above, that environmental management texts have tended to 'borrow' concepts and terminology from strategic management writing. It is not surprising, therefore, that in an attempt to understand the environmental changes that are occurring in organisations, analyses have tended to adopt similar conceptions of strategy. Hutchinson (1996) for example, develops a holistic argument for environmental strategy that embraces both a long-term vision of a sustainable organisation and the functional strategies that will be required to achieve those aims. This broad perspective of strategy (embracing both 'means' and 'ends') has come to be typified in the literature by organisations such as 'The Body Shop'. In contrast, De Simmone and Popoff (1997) describe the work of organisations such as Xerox who have chosen to pursue recycling and waste minimisation strategies (for example, with respect to packaging) specifically because it allows them to achieve cost savings and develop new markets. Examples of this narrower, competitive conception of strategy may be found throughout the environmental literature (see chapter three, sections 3.3 and 3.4).

For the purposes of ongoing discussion in this thesis, it is perhaps useful to draw from Chaffee's (1985) analysis the more holistic generalisation that strategy concerns the

decisions that the organisation plans to take with regard to future direction, and the processes by which those decisions are implemented.

Notwithstanding the debate surrounding the conceptualisation of strategy, contemporary analyses indicate that the rhetoric of strategy is strong, elevating the word to a terminological position synonymous with 'important' in fields well beyond the boundaries of management research (Whittington, 1993). As Jones (1998) suggests, this is perhaps rightly so because, in management there can arguably be no more important questions than, "why does this organisation exist, what is it trying to achieve and how can it achieve its objectives?" (p. 410). When reviewing how these questions have been addressed it is possible, over time, to identify views and propositions that in their contemporary context represented a 'mainstream' perspective in the field. Classifications have typically adopted a chronological stance in categorising authors as shown in Table 2.1 (adapted from Grant, 1995).

Period	Theme	Focus
1950s	Financial and project planning	financial control through operating budgets
1960s	Corporate planners and market forecasters	diversification popularised, the analysis of synergy and the diffusion of the multidivisional company (Ansoff, 1965; Williamson, 1985)
1970s	Portfolio planning	focus on strategic business units as the unit of analysis, planning matrices and experience curves (Henderson, 1984)
1980s	Analysis of industry and competition	focus on choice of industries, markets, competitor and the Profit Impact of Market Strategy (PIMS) analysis (Porter, 1985; Buzzel & Gale, 1987)
1990s	Competitive advantage	quest for competitive advantage through sources internal to the firm using resources and capability analysis (Rumelt, 1986; Teece, Pisano & Shuen, 1997)

Table 2.1: Mainstream Strategy Perspectives

This form of categorisation is useful for illustrating general trends and evolutionary shifts in focus, for example from the emphasis on market analysis in the 1980s as popularised by Porter (1985) to a focus on internal development characteristic of the resource-based perspective. It also clearly shows how the shape of organisations has changed in response to different strategic developments such as the diffusion of

multidivisional organisation and the popularisation of the strategic business unit. However, this chronological categorisation of strategy development says little about the underlying influences of each approach to strategy.

In his 1993 exploration of strategy, Whittington organises theories on the basis that approaches differ along two dimensions, "the *outcomes* of strategy and the *processes* by which it is made", (p.2, original emphasis). More specifically, approaches may be mapped according to the extent to which organisations seeks profit maximisation or more plural outcomes and, by the extent to which strategy is deliberately planned or emergent (Jones, 1998). Through this exercise Whittington generates four categories, as illustrated, with representative authors below.

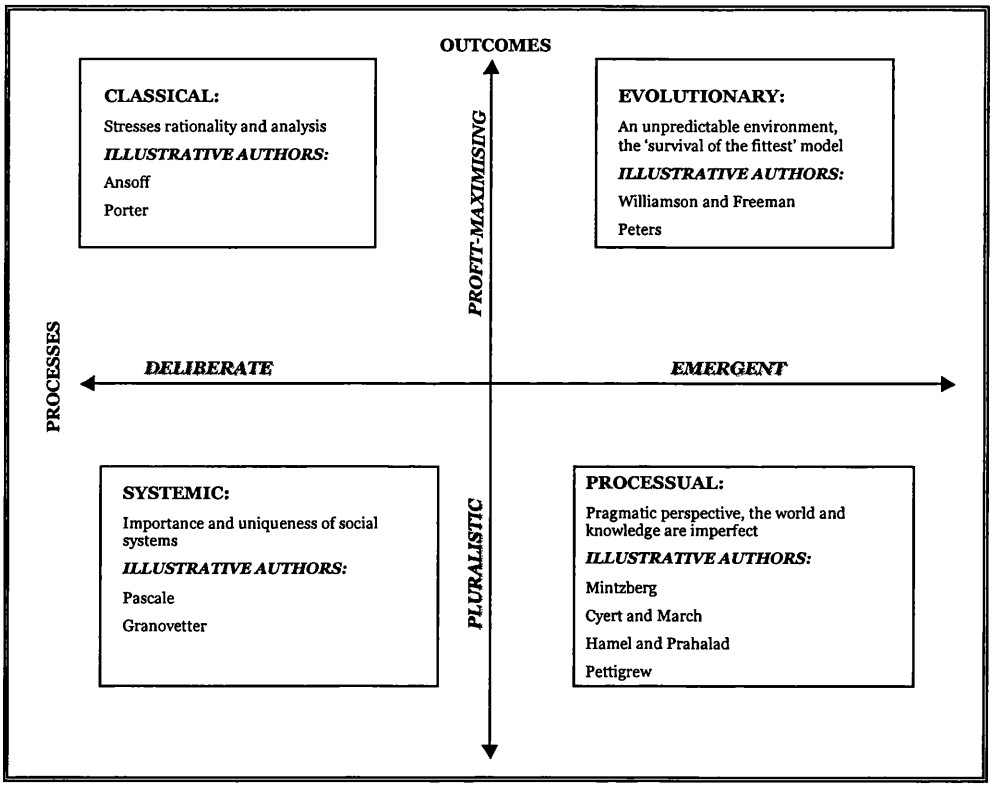

Figure 2.2: Whittington's Four Approaches to Strategy (adapted from Jones, 1998).

Whittington argues that it is possible to discern four generic approaches to strategy. His Classical approach is seen as relying on the rational planning methods prevalent in the 1950s and 1960s. The Evolutionary approach draws from the biological sciences in

arguing that competitive processes are akin to natural selection and that to a large extent organisations are at the mercy of the business environment (Henderson, 1980). The Processual approach emphasises the fallibility of both organisations and markets and suggests that, in practice, strategy involves a degree of pragmatic learning to fit the circumstances. The Systemic view is concerned with the social system in which strategizing takes place. Therefore while planning may be important, it may not necessarily be transferred successfully to a new context.

There are however, inherent difficulties in this form of classification. Although the axis should be viewed as continuum, the profit-maximising motives of Hamel and Prahalad's core competencies approach, for example, are demoted by grouping these authors with the processualists. In his representation Whittington tends, for emphasis to polarise these perspectives when it is more realistic to argue that overlaps exist. This is particularly the case when considering more recent approaches to strategy, such as resource-based thinking which have drawn lessons from across the authors' divides. It may therefore be more useful to consider the model as a heuristic or reference point (Jones, 1998).

Clearly any model aimed at understanding approaches to strategy is open to criticism whether it be more simplistic, for example a choice between ecological approaches and strategic choice or more detailed such as Mintzberg's ten 'schools of strategic thought'[2] (Jones, 1998). Nevertheless models do serve to highlight the tensions and the synergies inherent in the strategy debate. Additionally, the benefit of retrospective analyses affords a more holistic view as to how more recent strategic perspectives have developed.

[2] Mintzberg's (1990) ten schools of strategic thought.

- design
- planning
- positioning
- entrepreneurial
- cognitive
- learning
- political
- cultural
- environmental
- configurational

2.2.1 Summary

This section has introduced the eclectic and dynamic nature of the strategy debate through a brief review of approaches to strategy. It has illustrated that whilst the debate in academic terms is relatively young, it has an established depth and breadth. Conceptions of strategy vary and may be focused narrowly towards developing the most effective ways for businesses to compete in their respective markets, or be more broadly concerned with the visions and objectives as the business as a whole. Analysis of approaches towards environmental strategy suggests that work in this area has tended to reflect the conceptions developed in mainstream strategy. It was suggested that categorisations can artificially polarise approaches to strategy but, that they are useful in order to appreciate the underlying theories that guide dominant viewpoints. Additionally, understanding the origin and underpinnings of key perspectives can assist in the analysis of new and emerging schools of thought. An important contribution to the strategy debate has come from the increasingly popular Resource-Based View (RBV). The next section explores the evolution and contributions from this emergent view.

2.3 A Resource-Based View of the Firm

The resource-based approach to strategy has gained popularity throughout the 1990s after a decade of management 'fads' which have arguably been more damaging than beneficial to firms in the long term (Micklethwaite and Wooldridge, 1995). A growing disillusionment with market analysis (as typified by Porter's five forces model) and to an extent strategy in general, has been replaced by an enthusiasm for a perspective that appears to build systematically on the strengths and weakness of previous approaches to strategy. This has been achieved by marrying an understanding of the external environment with a more critical and thorough appraisal of internal firm capabilities. Resource-based thinkers use two basic empirical generalisations:

- that there are systematic differences across firms in the extent to which they control resources that are necessary for implementing strategies;
- these differences are relatively stable (Foss, 1997, p. 4).

In addition it is assumed that differences in the capacity of firm resources can cause variation in performance and that the aim of the firm is to where possible increase or improve performance.[3] Therefore as Foss (1997) indicates, the overall objective informing the RBV is to, account for the creation, maintenance and renewal of competitive advantage in terms of the resource side of the firm.

> "More specifically, [we] are interested in linking the explanation of competitive advantage and the dynamics of competitive advantages, to the characteristics of resources and how these characteristics change over time." (Foss, 1997, p. 4)

In the literature, it has been possible to witness an increasing application of this perspective to established areas of business research such as innovation, as well as more contemporary management issues such as the natural environment (Clarke and Pitt, 1996; Hart, 1995; Sharma and Vrendenberg, 1998). The next section considers the origins of the RBV and analyses the contributions and influences of key authors. The discussion also draws out areas of disagreement and difficulties that have emerged as the RBV has developed in a contemporary context. Where appropriate, I state my position on conceptual and terminological issues.

2.3.1 Historical Foundations

Several key authors, when considered cumulatively, have provided the conceptual and terminological building blocks for the development of the RBV. Philip Selznick (1957), writing from what later became know as the 'institutional' perspective in organisation theory, was one of the first writers to coin the term, 'distinctive competence'. Selznick wrote from a sociological standpoint about leadership in 'administrative' organisations. He argued that an organisation's 'character' was capable of conferring both distinctive competence or alternatively, inadequacy.[4] More specifically he pre-empted some of the key characteristics of resource-based thinking, such as path dependency and 'routines', in outlining that the concept of character was composed of:

- a *historical* element that reflected the specific experiences of the organisation;
- a *functional* part that enabled the organisation to adapt to its internal and external social environment;

[3] A view akin to Whittington's Processualists, i.e. not necessarily profit-maximising.

- a *dynamic* element that generates new, active forces, especially internal interest groups;
- a discernible pattern of *integration* discoverable through analysis (Selznick, 1957, p. 39).

Selznick (1957, p. 139) implied that this 'character' development was a social process that occurred 'unconsciously' a view which is inherent in more recent work on the value of tacit knowledge and intangible resources (Hall, 1992; Harvey and Lusch, 1997). This notion that different firms develop different 'distinctive competence' as a result of their heterogeneity has become an integral part of the RBV.

One of the most important and oft cited contributions towards the RBV derives from Edith Penrose's 'Theory of the Growth of the Firm' (1959). She argued that the firm,

> "is essentially a pool of resources the utilisation of which is organised in an administrative framework." (1959, p. 149)

Penrose, while holding on to some key neo-classical perspectives such as profit-maximisation, made a major departure from existing economic theory by entering the 'black box' and considering the firm as unique and heterogeneous. She shifted attention, in part, from products and markets, by emphasising resources internal to the firm, arguing that the forces driving change and adaptation were to be found mainly at this level (Pitelis and Wahl 1998). In addition she highlighted the role of objective knowledge, and in particular, experiential knowledge. While objective knowledge is considered transferable, experiential knowledge she argued, is tied more closely to the individual or group. As a result, this form of knowledge is inherited or path dependent indicating crucially that "history matters". As Pitelis and Wahl (1998, p.253) argue in their analysis of Penrose,

> "... the nature of the firm [according to Penrose] is characterised in particular by the heterogeneity of the underlying knowledge-based resources."

Penrose's view of the firm is therefore one where the more precious resources are tacit and socially complex, tied up both in experience and team capital. These features, in

[4] This two sided notion of character is interestingly mirrored in the contemporary work of Leonard-Barton (1992), where she argues that core competencies may also be core rigidities, when they act to constrain new innovation.

particular its specificity, make it non-tradable and distinctively valuable beyond the short term.[5]

The contributions of Chandler (1962) to the RBV of the firm have perhaps less immediacy than those of Penrose. His seminal study of the evolution of strategy and structure in American business is predicated on a rational approach to strategy that places his work firmly in the Classical quadrant of Whittington's (1993) classification. However, Chandler made some key propositions that relate to resource-based thinking. In his definition of strategy he points to the necessity of appropriate *resource* allocation to attain strategic goals. He indicates that the total resources of the firm comprise not only physical equipment and raw materials but also information, data and the various skills of its personnel (Chandler, 1962). These resources are organised in an administrative framework, which he argues differ according to different types of growth. These differing forms, for example the multidivisional form in response to diversification, and their relationship with strategy determine the fortunes of the firm over time. This naturalistic account is as (Moore, 1992) suggests sharpened by his now famous statement that structure follows strategy. That is, a change for example in technological development[6], may call for the allocation of new resources. This strategic change over time has a profound effect on the form or structure of the organisation and its success in the marketplace (Chandler, 1962). The relationship between resource composition, their application and the subsequent implications for strategic success can be seen mirrored in the contemporary RBV of the firm.

I suggested earlier that definitions of strategy have been hotly debated in the area of strategic management. While acknowledging that there exists ongoing disagreement, it can be argued that Andrews offered one of the classic and most enduring definitions of strategy. He viewed strategy as a matter of aligning the *key strengths* (resources) of the organisation with the *opportunities* of the environment, at an acceptable level of risk, (Andrews, 1980). More specifically Andrews (1980), considered strategy to be comprised of four components:

[5] Hence the value of mergers or acquisitions where companies look to 'acquire' the experience of management teams that is otherwise inaccessible.

[6] In Chandler's view the stimuli for strategic change are always external (Moore, 1992).

- market opportunity;
- corporate competence and resources;
- personal values and aspirations;
- acknowledged obligations to people in society other than shareholders.

The chronological categorisation presented above, shows how over time, the emphasis in different strategic approaches has shifted between the internal and external environment. The 'framing device' presented by Andrews incorporates both domains and has considerable resonance with contemporary resource-based perspectives. Of note is his focus on understanding corporate capability or what the company *can* do which as Foss (1997) argues, relates to the notion of 'productive opportunity' put forward by Penrose. Andrews also talks about the role of the team in his consideration of organisational leaders and managers which again is reflected in Penrose's work.

A significant number of contributions to the RBV of the firm derive from an economic perspective. Richardson (1972), writing about, 'The Organisation of Industry' is no exception to this, but as with many of the more recent contributions from resource–based scholars, he questions some of the premises of economic thinking. He argues that rather than viewing firms as 'islands' they should be considered as linked together in patterns of co-operation and affiliation. In his discussion he makes the case for viewing industry (organisations) as undertaking *activities* which comprise manufacturing, research, development and marketing. Activities, he suggests, need to be undertaken by organisations with *appropriate capabilities*. Richardson conceptualises capabilities as composed of knowledge, experience and skills. He argues that while this notion may be considered vague, it is nevertheless of value. Critically he argues that organisations, "specialise in activities for which their capabilities offer some comparative advantage" (1972, p. 61). Richardson's contribution also draws explicitly on Penrose in arguing for attention to be given to the *human* element of organisation (experience and skill) and its contribution towards production.

A review of historical contributions to, and synergies with, the RBV would not be complete without consideration of Nelson and Winter's (1982), 'Evolutionary Theory of Economic Change'. Nelson and Winter's evolutionary approach while founded on economic rationale, sits outside the mainstream of economics. Their work

conceptualises firms by drawing on the biological concepts of variation (innovation), heredity (knowledge-bearing) and selection (market selection). In their framework, firms are conceived as possessing path dependent knowledge bases (bundles of hierarchically arranged 'routines') (Foss et al, 1995). Routines they suggest, are the way that organisations store specific operational knowledge. The 'memory' of a routine is achieved experientially rather than through codified or formal documentation procedures. Therefore, routines are embedded in a firm and change slowly over long periods of time, influencing the development of new routines (Montgomery, 1995). Nelson and Winter (1982) also make the case for the value of tacit knowledge[7] in both underpinning and determining the nature of routines. The notion of routines, their composition and the nature of tacit knowledge have become an important part of the RBV.

2.3.2 Summary

The authors discussed above are collectively considered to have provided the foundations for resource-based perspectives. Their contributions vary from supplying a framework for strategy analysis (Andrews, 1980), providing new points of entry for the analysis of firm competitive advantage (Penrose, 1959), conceptualising capability (Richardson, 1972), to introducing terms and concepts (Selznick, 1957; Nelson and Winter, 1982). The measure of their contribution to modern resource-based work is determined largely by the extent to which contemporary authors refer to the ideas proposed by these writers. The work of Penrose in particular is claimed as an antecedent for many authors (Mongomery and Wernerfelt, 1988; Mahoney and Pandian, 1992; Peteraf, 1993). In considering these works chronologically I am aware, as Foss (1997) rightly considers, of the danger of 'rational reconstruction'. It is frequently easier to discern themes and commonality by grouping contributions to the literature retrospectively. Barney (1995) in particular contests this historical story suggesting that the RBV grew from debate between economists and strategy scholars such as Richard Rumelt, Oliver Williamson, Sidney Winter and himself. Therefore, while it may be argued that the work reviewed has only belatedly been considered to anticipate contemporary resource-based thought, it is clear that the conceptualisations of these authors continue to impose value through the power of citation. As I shall show

[7] The term coined by Polanyi (1962) in his book, Personal Knowledge: Towards a Post-Critical Philosophy, for knowledge that cannot be articulated.

in succeeding discussion, issues such as firm heterogenity, the resource as the unit of analysis and firm capability, flow through more recent writing from the RBV.

2.4 Contemporary Developments

I have illustrated that key concepts and terms now associated with resource-based thinking have been drawn from a range of authors whose backgrounds encompass the disciplines of economics, industrial organisation and strategy. This spread of contributions continues to enrich more contemporary work in the field, with the influence of economics perhaps the most prevalent. The strength of the economic perspective relates arguably to the clarity conferred by economic principles in the resource-based conception of competitive advantage[8]. However, as critiques of the resource-based perspective have observed, the strength of traditional economic thinking is increasingly eclipsed by the application of new economic theories to strategy. These issues are debated more fully in section 2.7.2. The following section analyses in more detail the recent contributions to the RBV. It considers the development of concepts proposed in the preceding literature and examines how different approaches and emphases have witnessed a branching and expansion of the field.

The RBV and the associated volume of writing showed a resurgence of interest in the mid 1980s. Writing in 1984, Wernerfelt advanced a resource-based perspective on both competitive advantage and growth. He proposed that firms be considered in terms of their resources rather than their products. In his analysis resources are considered to be,

> " ... anything which could be thought of as a strength or weakness of a given firm." (Wernerfelt, 1984, p. 172)

As examples he cites resources including, brand names, efficient procedures and in-house knowledge of technology. Wernerfelt's key contribution is derived from his introduction of the concept of *resource position barriers*. He argues that the ownership of a given resource affects the costs and/or revenues of subsequent acquirers adversely,

[8] In economics, resources that are both valuable and rare are considered to yield a distinct return or rent. If it is either difficult or prohibitively expensive to imitate or substitute this resource with another that performs the same task then the rent may be long lived (Foss, 1997).

and in doing so protects the holder of the resource creating a barrier and providing an advantage (Wernerfelt, 1984, p. 173). This resource position barrier relates closely to the existing concept of the entry barrier because,

> " ... *an entry barrier without a resource position barrier leaves the firm vulnerable to diversifying entrants, whereas a resource position barrier without an entry barrier leaves the firm unable to exploit the barrier.*" (Wernerfelt, 1984, p. 173, original emphasis)

Wernerfelt develops his idea through a resource-product matrix, which demonstrates the value of developing resources in one market in order to facilitate entry into new markets.[9] For example, supporting production skills through domestic contacts may bring cost effects that in turn support the acquisition of international contacts. Growth, he suggests (drawing on the work of Penrose) involves a balance between the utilisation of existing resources and the progression of new ones. However, as Wernerfelt notes in his analysis, this work leaves a number of unanswered questions including how to actually go about identifying resources and the extent to which resources may be effectively combined. In addition the author relies on models of 'rational' behaviour. This economic basis is also reflected in Rumelt's work, which was published simultaneously.

Rumelt (1984) however, allies his position more closely to developing evolutionary economic theory and in doing so makes the case for a closer relationship between insights from these economic concepts and business strategy. Rumelt is critical of existing writing on business strategy observing that for the most part it [strategy] is composed of empirical observations and concepts that have no theoretical grounding. An argument, that is mirrored in analyses of contemporary environmental management writing, and is expanded in subsequent sections. He argues that when considered from the perspective of economics:

> "The chief concern of business policy researchers has not been static profit maximisation but profit seeking through corporate entreprenuership, and with the empirical observation that corporate entreprenuership is ultimately connected with the appearance and adjustment of *unique* and *idiosyncratic resources.*" (Rumelt, 1984, p. 134, emphasis added)

[9] A 'stepping stone' effect which is illustrated by Prahalad and Hamel (1990) in their Core Competencies work.

Rumelt suggests that neo-classical theory does not adequately consider these aspects of entrepreneurship and resource heterogeneity. While recognising the difficulties, he makes an attempt to model Schumpeterian or strategic competition.[10] His model of *'uncertain imitability'* depends on,

> "... viewing strategy as entrepreneurship that both depends on and creates inter-firm heterogeneity ..." (Rumelt, 1984, p. 143).

Specifically he argues that uncertainty in the creation of new production functions is most likely to occur because there is an ambiguity as to what the factors of production actually are and how they interact. This *causal ambiguity*, which prevents competitors from fully understanding efficiency differences, limits competition by entry or imitation (Rumelt, 1984, p. 136). Additionally, causal ambiguity acts, in turn, as an *isolating mechanism* protecting the first mover. Isolating mechanisms may take a number of forms as illustrated in Table 2.2.

Sources of Potential Rent	**Isolating Mechanisms**
Changes in technology	Causal ambiguity
Changes in relative prices	Specialised assets
Changes in consumer taxes	Switching and search costs
Changes in law, tax and regulation	Consumer and producer learning
Discoveries and inventions	Team-embodied skills
	Unique resources
	Special information
	Patents and trademarks
	Reputation and image
	Legal restrictions on entry

Table 2.2: Elements of Strategic Position (source Rumelt, 1984, p. 141).

These propositions have increasingly become recognised as important components of the RBV. In developing a perspective of resource-based thinking it is apparent that authors contributions are developing a framework that reflects a position where:

[10] Schumpeterian theory considers innovating entrepreneurs to be the driving forces in the system. The selection environment is considered to be dynamic rather than in equilibrium, with the essential forces of growth being innovation and selection.

- the firm should be viewed as heterogeneous;
- the factors that make a resource a source of competitiveness are hard to identify;
- the firm-specificity of resource development is an important contributory factor to the value that can provide competitive advantages.

Importantly though, these concepts as presented, are far from clear cut. The causal ambiguity that makes a resource hard to imitate may render it equally hard to maintain and replicate within the firm itself. This suggests a need to understand in more detail the nature of firm skills and capabilities. In his consideration of strategic factor markets Barney (1986) adds weight to the case for systematic organisational analysis. Firms, he argues, may chose to implement a strategy through the acquisition of resources. For example, improved product innovation will require additional research and development skill. However,

> "...to obtain above normal returns from implementing product market strategies [firms] must have consistently more accurate expectations about the future value of those strategies when acquiring the resources necessary to implement them." (Barney, 1986, p. 1239)

This superior knowledge (although Barney also admits that luck may sometimes be a factor) is it is argued, most effectively obtained by an inward focus on resources already under the firm's control. In this way potential synergies and complementarities between resources that afford competitive advantages are more likely to be identified.

Barney (1991) progresses this focus on the relationship between a firm's internal characteristics and performance by examining how the RBV may be operationalised. He develops a framework of four empirical indicators in order to assess the potential of firm resources to generate sustained competitive advantage. Barney's (1991) model builds on the assumption (as introduced in the discussion above) that a firm's resources may be both heterogeneous and immobile. He proposes that a resource requires four attributes:

1. It must be valuable, in the sense that it exploits opportunities and/ or neutralises threats in the firm's environment;
2. It must be rare among the firm's current and potential competition;
3. It must be imperfectly imitable;

4. There cannot be strategically equivalent substitutes for this resource that are valuable but neither rare or imperfectly imitable (Barney, 1991, pp 105-106).

The modelling of the relationship between resource-based assumptions, resource attributes and sustained competitive advantage[11] is illustrated in Figure 2.3 below.

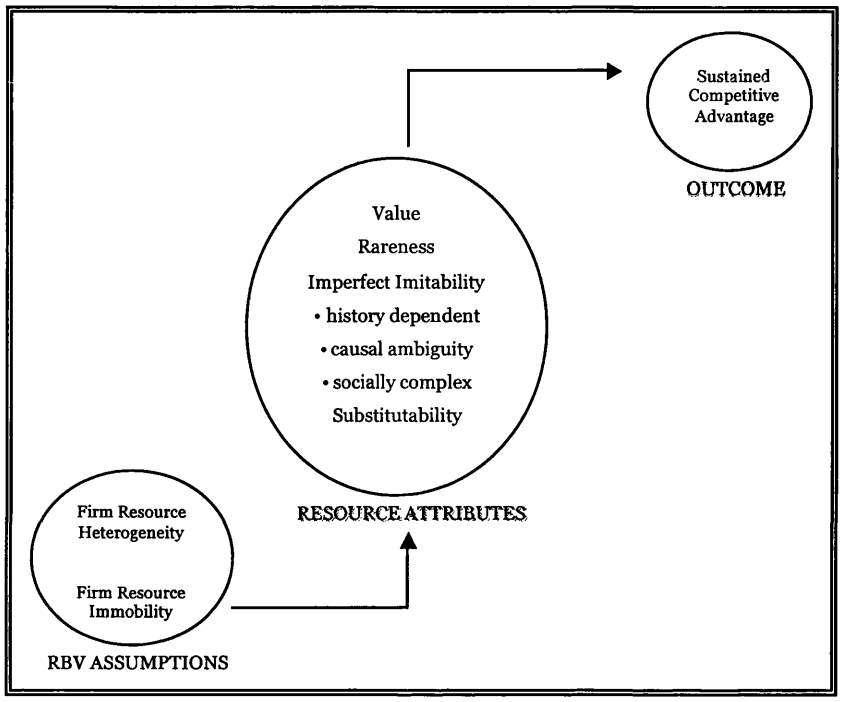

Figure 2.3: The Relationship Between RBV Assumptions, Resource Attributes and Sustained Competitive Advantage (adapted from Barney, 1991, p. 112).

Barney's contribution is significant in that it develops the RBV by isolating key concepts, in particular uncertain imitability. He breaks down this concept by using criteria presented by previous authors, history dependence (Penrose, 1959), causal ambiguity (Rumelt, 1994) and by introducing an additional element of his own, social complexity. Social complexity, he argues, is tied up with people skills rather than physical technology. This relates to some of the more tacit and knowledge-based concepts discussed above.

[11] Barney differentiates sustained competitive advantage from competitive advantage by arguing that this sustained condition exists only when a value creating strategy is unable to be duplicated by competitors (1991, p. 102).

Barney also provides a framework for moving the conceptual deliberations of authors into the empirical arena. This framework has applicability across a range of contexts as observed in subsequent sections. In addition, Barney makes moves to tie the RBV and its strong economic influences more closely with organisational theories (for example relating to organisational learning) by arguing that the RBV may provide insights to organisational and social phenomena. Again, this relationship to organisational learning is drawn more closely in subsequent discussion.

A large volume of the resource-based contribution is consolidated in Petraf's (1993) model, 'the Cornerstones of Competitive Advantage'. Drawing on the authors discussed above and other notable contributions from Dierickx and Cool (1989) and Mahoney and Pandian, (1992) she proposes a four pronged model which,

> " ... integrates existing perspectives into a parsimonious model of resources and performance." (Petraf, 1993, p. 1 79)

The model is based on four conditions:

- Heterogeneity;
- *Ex-post* limits to competition;
- Imperfect mobility;
- *Ex-ante* limits to competition.

Petraf suggests that the condition of heterogeneity is present in both Ricardian and Monopoly models of rent.[12] While the Ricardian model is usually applied to resources which are fixed, Petraf argues that it may be applied to quasi–fixed resources, i.e. those that while limited, may be incrementally expanded and developed in the firm. In the Monopoly situation where rents result from the deliberate restriction of output rather than inherent scarcity in resource supply, heterogeneity may result for example from, spatial competition, product differences, mobility barrier or first mover advantages (Petraf, 1993, p. 182). *Ex-post* limits to competition require that the condition of heterogeneity be maintained. As I have shown in the analysis above, resource-based writers have focused in particular on the factor of imperfect imitability through

[12] Ricardian or economic models of rent are thought of as accruing to *owners* of unique factors, for example a firm could earn Ricardian rents if it owns attractively located land or holds a patent (Montgomery and Wernerfelt, 1988).

concepts such as isolating mechanisms and causal ambiguity which frequently relate to organisation specific skills and learning.

Imperfect mobility implies that while potentially tradable, resources are less valuable outside the originating firm. This may be because they are specialised to firm-specific needs or derive their value only when used in conjunction with another resource (Petraf, 1993). Alternatively the transaction costs associated with their transfer could be exceedingly high. Finally Petraf argues that to maintain competitive advantage their must be *ex-ante* limits to competition. That is, in establishing a resource position there must be limited competition for that position. So as Barney (1986) notes, performance depends not only on the returns of a strategy but also on the costs of implementation. These points are summarised in Petraf's 'cornerstone' model.

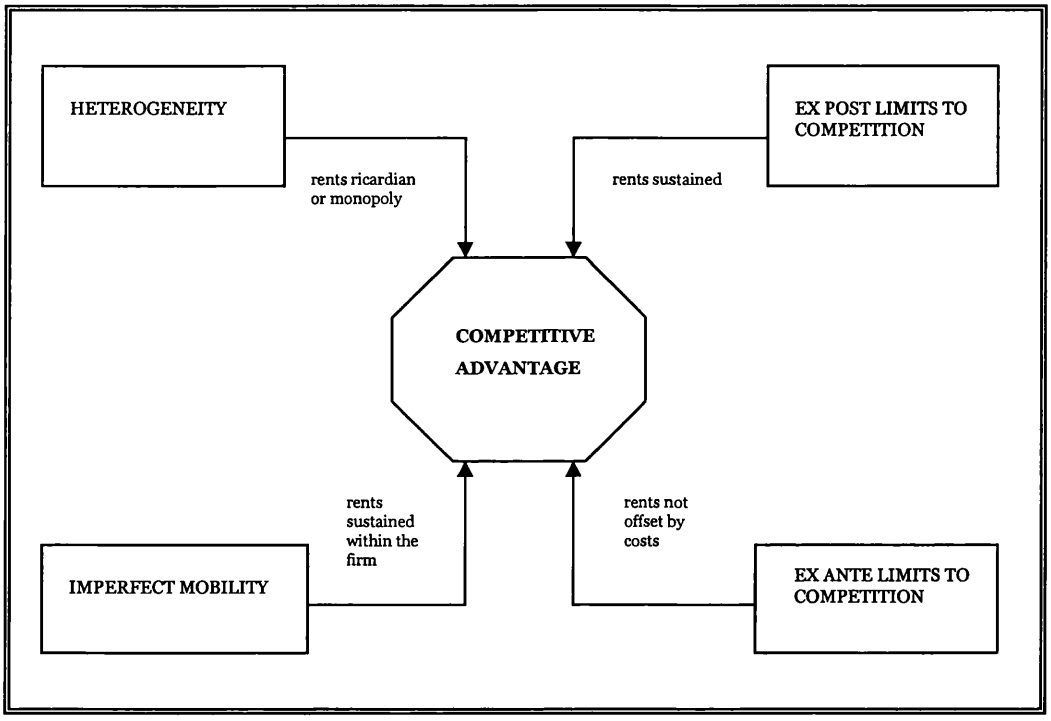

Figure 2.4: The Cornerstones of Competitive Advantage (Petraf, 1993).

Petraf's model effectively consolidates outstanding perspectives by drawing together the key concepts that collectively distinguish the RBV from alternative approaches to strategy. This work she argues has both theoretical implications and practical applications for business managers.

The industrial organisation origins of the elements highlighted by the 'cornerstone' model are comparatively analysed by Conner (1991). She shows that collectively authors have attempted to distinguish a resource-based approach by drawing on different aspects of economic models and theories of the firm. To determine the credibility of this move towards a new theory, Conner (1991) systematically compares resource-based work to five industrial organisation predecessors. She does so by highlighting similarities and differences in theoretical and empirical approaches to theories of the firm as illustrated in Table 2.3.

Theory	RBV Similarities	RBV Distinctions
Neo-classical	• firm as input combiner; emphasises physical production of goods and service	• no given production algorithm, identification of resources and resource combinations is problematic • critical resources may be immobile, or by-products of team work • firm size and scope are important issues
Bain-type IO	• firm's environment poses critical constraints on strategy • persistent above normal returns are possible	• restraints on output through monopolistic or collusive action are not primary sources of persistent rents • the firm is the appropriate unit of analysis • the internal organisation of the firm is a critical variable • firm behaviour relates to conscious choice and industry structure in almost equal measure
Schumpter	• large above normal returns can result from new ways of competing • entrepreneurial vision is at the heart of the firm • potential imitators always exist	• new ways of competing do not rest on monopolistic practices • imitators are constrained by costly to copy resources • exogenous shocks can aid 'creative destruction' • healthy earning can result from less than revolutionary innovation
Chicago	• firms are production and efficiency seekers • size and scope of the firm reflect the extent to which production and distribution efficiencies are achieved	• focus on the intermediate term • efficiency seeking extends to new products
Coase/ Williamson transaction costs	• asset specificity and small numbers are critical concepts in constraining the firm's strategic options	• the centre of the firm focuses on deployment and combination specific inputs rather than on avoidance of opportunism

Table 2.3: A Comparison of the RBV to Five Theories of Industrial Organisation (adapted from Conner, 1991, p. 133).

Conner's comparative analysis shows that the RBV has a strong cumulative heritage in industrial organisation economics as observed in the perspectives of authors considered in this discussion. However, she highlights several key issues raised by the resource-based approach.

First, she notes that the focus of the RBV on unique inputs and capabilities results on a concentration on *differences* rather than *similarities* and that generalising about uniqueness is not theoretically practical. Additional concern is raised with regard to the level at which resources are defined. Conner's analysis suggests that 'hierarchies' of resources exist. By implication these levels may 'aggregate' for example from individual skill, to organisational culture and ultimately organisational reputation. Conner argues that attention needs to be given to contributions and performance in relation to level. She also notes that using outcomes of resource application as a proxy for underlying resources is empirically difficult and poses a problem for researchers (Conner, 1991, p. 145).

2.4.1 Summary

I have shown in the review of selected contemporary writing on the RBV of the firm that the volume and richness of perspectives has provided new ways of looking at the strategic activity of the firm. However, contributions have tended to draw inspiration from a range of sources which has hindered progression towards an agreed set of tools and conceptual frameworks. Several authors have moved some way towards remedying the situation by consolidating (Petraf, 1993) and operationalising (Barney, 1991) key concepts. Nevertheless critiques of resource-based thinking, particularly from within the field are less forthcoming. The issues highlighted above, are therefore considered alongside other issues raised by the resource-based perspective in a more critical examination in section 2.10.

Before moving on to consider the problems that have arisen during the development of the RBV it is important to consider the more recent and in many ways the most influential application of resource-based research.

2.5 Core Competencies and Dynamic Capabilities

While the authors analysed above have laid the foundations for resource-based work, it is widely accepted that the popularisation of the RBV owes much to the work of

Prahalad and Hamel (1990) through the development of their core competencies concept (Scarborough, 1998). The following section examines the core competencies approach and the allied work of Teece, Pisano and Shuen (1990) on dynamic capabilities. Collectively these authors have arguably popularised the RBV in the field of strategic management.

Many writers in the field (Foss, 1997; Scarborough, 1998) for example, consider Prahalad and Hamel's (1990) article seminal. As the most requested reprint in the history of the Harvard Business Review it could be considered a deserved accolade. In presenting their case, Prahalad and Hamel made a clear, strong statement. They proposed that corporations needed to rethink[13] how to go about gaining competitive advantage. Using empirical examples from large, well know firms such as NEC, GTE and Honda they argued specifically that:

> "The real sources of advantage are to be found in the management's ability to consolidate corporate wide technologies and productions skills into competencies that empower individual business to adapt quickly to changing opportunities." (Prahalad and Hamel, 1990, p. 81)

Competencies they suggested, were a result of collective learning in the organisation driven by communication and a commitment to work across boundaries. They do not consider competencies to be physical assets. According to the authors, key elements for generating success through core competencies relate to having or developing a 'strategic architecture'. This they propose, is a 'road map of the future' that identifies which core competencies to build and their constituent technologies. A key identified hindrance is the existence of the strategic business unit (SBU). These issues are summarised in Table 2.4.

CORE COMPETENCIES	
Key elements	• collective learning • communication • involvement • cross organisational boundary working
Mediating Factors	• strategic architecture • a 'vision' of the future
Moderating Factors	SBUs, which result in: • underinvestment • imprisoned resources • bounded innovation

Table 2.4: Key Elements of Prahalad and Hamel's Core Competencies Concept

[13] In particular they were arguing for a rethink of the 'industrial analysis' models.

A key element of Prahalad and Hamel's work has been to bring a managerial perspective to the RBV of the firm which appears to contribute to a more practically applicable theory of strategic management. As Sanchez and Heene (1997) note, competence based competition draws together some of the more fragmented perspectives of strategy that have characterised the 1980s[14].

This perspective is developed by Teece et al (1997) through a *dynamic capabilities* approach. Capabilities they suggest should be understood,

> "... mainly in terms of the organisational structures and management processes which support productive activity." (Teece et al, 1997, pp. 269-270)

More specifically, however they differentiate dynamic capabilities as a subset of capability, which allow the firm to create new products and process and respond to changing market circumstances. As they cannot be bought, dynamic capabilities need to be built. In taking this approach the authors build on the RBV by focusing on the notion (introduced above) that scarce resources can be a source of economic profit. However, they argue that the dynamic capabilities perspective represents an extension of the RBV of the firm as a bundle of resources. This is because their dynamic approach focuses on:

> "The *mechanisms* by which firms *accumulate* and *dissipate* new skills and capabilities and the *forces that limit the rate and direction* of the process." (Teece et al, 1991, p. 19, emphasis added)

They conceptualise dynamic capabilities along three strategic dimensions:

- managerial and organisational processes (the way things are done in the firm);
- position (current endowment of technology, intellectual property and relations with suppliers and customers) and;

[14] An integration of approaches which Sanchez and Heene (1997) argue span economic and behavioural / organisational perspective to include:

- game theory;
- re-engineering;
- core competencies;
- learning organisations;
- strategic HRM.

- paths (strategic alternatives to the firm and their attractiveness) as illustrated in Figure 2.5 .

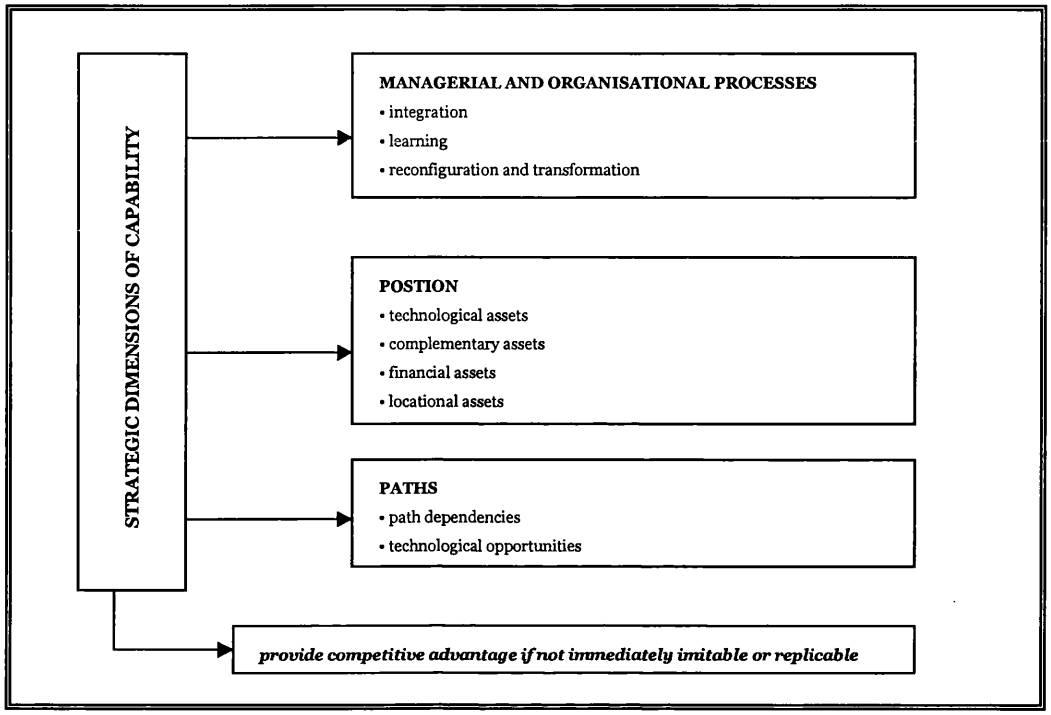

Figure 2.5: Strategic Dimensions of Capability (after Teece et al, 1997).

Teece et al (1997), build more explicitly on evolutionary economic theory and in doing so reflect the general trend of resource-based contemporary writing. By introducing a dynamic element they make an attempt to grapple with the more difficult issues associated with resource creation. As Foss (1997) suggests, the lack of a clear conceptual model of endogenous resource creation, is one the underlying problems with the RBV. I would argue that attempts to elucidate the 'dynamics' or 'mechanisms' of resource creation have been rather loosely assembled and informal. Therefore, although the framework provide by Teece et al (1997) is useful, much work remains to be undertaken in this area.

2.5.1 Summary

This branching of resource-based work to consider the dynamics of resource creation adds an important element to the RBV. However, when the literature is viewed as a whole it adds an additional analytical frame to an, at times, incoherent grouping of

perspectives. The variety of sources and eclectic use of theory has arguably militated against the credibility of the RBV when compared for example with the more established Classical approach to strategy (see Figure 2.2).

I have indicated that explicit criticisms from within the field have been few. Nevertheless, I have suggested that the road to resource-based work has presented a number of issues and problems which merit further examination. These issues are explored in more detail in the next section.

2.6 Issues in Resource-Based Thinking

The apparent success of resource-based perspectives is increasingly reflected in mainstream strategic management texts (see for example, Grant, 1995). As I suggested above, it is tempting to retrospectively impose a chronological coherence to these writings. This arguably serves to mask underlying disagreements between authors.

2.6.1 Terminology

The status of the RBV as 'emerging' (Foss, 1997) or 'reaching for theory' (Conner, 1991) is appropriate when considering, for example, the use of terminology. The terms 'resources', 'competencies' and 'capabilities' are to a large extent used interchangeably. However some authors make distinctions, for example, differentiating between competencies as an immanent resource, and the capabilities which apply [them] to competitive goals (Post, 1997). That is, capabilities integrate and mobilise competencies. This is confusing both when comparing existing texts and for new entrants into the field. My preference is in agreement with Segal Horn (1998) in adopting Grant's (1991) distinction between resources and capabilities. He states that:

> "Resources are inputs into the production process, they are the basic units of analysis. The individual resources of the firm include items of capital equipment, skill of employees, patents, brand names, finance and so on. But, on their own few resources are productive. A capability is the capacity of a team of resources to perform some task or activity. While resources are the source of a firm's capabilities, capabilities are its main source of competitive advantage." (1991, pp. 118-119)

Analysis of the literature suggests that the terms capability and competency are most usefully viewed as synonymous, and for the purposes of subsequent discussion will be

considered as such.[15] These tautological tendencies have also been levelled at resource-based reasoning (Porter, 1994; Mosakowski and McKelvey, 1995). This criticism is important because it challenges how the RBV of the firm is conceptualised and operationalised. These issues are brought into focus by the mix of theoretical perspectives adopted by authors.

2.6.2 Theoretical issues

The RBV has to a large extent relied on economic theories of the firm, as illustrated by Conner's (1991) comparison. It is apparent that this is viewed as conferring rigor or inherited discipline on the RBV. However, economics has tended to adopt a static view of the firm which does not necessarily sit well with perspectives such as Penrose's endogenous change through managerial discretion (Foss, 1997). Equilibrium concepts also hinder progress toward the process issues which the RBV is implicitly considering. Interestingly Rumelt (1995), supports this view arguing that the foil of RBV strategy research (neo-classical economics) has in fact been replaced by game theory, agency theory and transaction cost economics. He argues that assumptions such as plasticity, rationality of collective action and homogeneity of belief do not necessarily serve the strategy arena well. In particular, he highlights the issue of plasticity, noting that in reality strategic change is, "difficult, costly, risky and time consuming" (Rumelt, 1995, p. 103). An observation which interestingly challenges some of the key tenets of Prahalad and Hamel's arguments which rely on swift organisational adaptation.

Increasingly however, authors are suggesting that formalisation need not necessarily be lost by modelling more dynamic processes. This view has been popularised by growing attempts to strengthen links between the RBV of the firm and evolutionary economics (Montgomery, 1995). Authors writing from this perspective draw most notably on the intellectual heritage of Nelson and Winter (1982) in attempts to generate more dynamic conceptualisations that allow for process issues of heterogeneity and change without abandoning formal modelling. While it is possible to identify clear differences between the two schools of thought there are also dimensions where their synergistic views may

[15] It is important to note that while this distinction is generally applicable across the texts I have considered some authors do make an additional distinction. Teece et al (1990) in particular, argue that it is only *dynamic* capabilities that deliver competitive advantage and not capability *per se*. I would argue that whilst this distinction is conceptually attractive it is more difficult to consider in an empirical context and will therefore not be adopted in this discussion.

be complementary. [16] For example the RBV considers in principle, all resources to be of potential value.

Notably however, authors have progressively suggested that it is the more 'intangible' resources such as human resources and reputation that may be key. Evolutionary theorists argue that it is specifically these intangible resources that comprise routines, and it is routines, which when articulated may generate profit. Evolutionary theorists are also concerned with 'heritage' and as I have noted in the above analysis the RBV has also been influenced by notions of path dependency and the role of a firm's history. These example synergies and the move towards a more dynamic conceptualisation of resource-based thinking suggest that some compromise and marrying of perspectives may be valuable.[17]

The RBV of the firm considers change and competency development to be an evolutionary process that, with reference to its economic roots, reflects a (bounded) rationality of choices and decisions with regard to optimising resources. However, as I suggested when making reference to knowledge and learning, the RBV is increasingly tackling organisational phenomena in order to understand how resources are developed and competencies are deployed. By encompassing notions of knowledge accumulation and collective learning authors are implicitly looking to organisational theories for inspiration. Interestingly this highlights the tendency of the RBV to objectify knowledge in organisations and in doing so abstracting it from its situated and socially constructed origins (Scarborough, 1998). The increasingly managerial focus of the RBV (as it is managers who ultimately make the decisions about cultivating and deploying resources), suggests that complementarity may be gained from a closer appreciation of work in organisational learning.

This shortfall in considering social phenomenon also extends to the firm's external environment or context. External factors in the RBV are strategic industry factors for

[16] Evolutionary economics tends to focus on industry-level analysis and seeks to explain technological evolution and competition. Resource-based theorists focus on firm-level analysis in seeking to explain sources of competitive advantage and diversification (Foss et al, 1995).

[17] This is particularly the case when we consider the evolution of new products and processes in the firm. Innovation management draws heavily on evolutionary theories of technological change and has more recently been enhanced by competency informed perspectives which have their roots in resource-based thinking (Loveridge and Pitt, 1990).

example, buyer/ supplier power, intensity of competition and product market structure. As a result, the RBV has largely ignored the social context within which decisions are embedded (for example, firm traditions, network ties, regulatory pressures) and how this context may affect sustainable firm differences (Oliver, 1997, pp. 697-698). These issues may have explanatory power when considering how firms make choices with regard to resources and it may therefore be beneficial to combine insights from institutional theory[18]. I would argue that this is particularly relevant in an environmental management context and represents an important adaptation of resource-based thinking for subsequent discussion, which considers the specific application of the RBV in an environmental context.

2.6.3 Empirical issues

I identified above, Conner's (1991) observation that the RBV focuses on unique elements of the firm which creates empirical difficulties. That is, the key information sought by managers relates to differences rather than similarities. This focus on uniqueness or the best resources is also highlighted by Montgomery (1995), in relation to RBV research. She argues that strategy scholars have a tendency towards 'optimism' and this drive has resulted in a rather narrow focus on what she terms the 'crown jewels' of the firm. An exemplar of this critique would be Prahalad and Hamel's work on successful core competencies in large organisations. Consequently Montgomery suggests that RBV scholars have singularly ignored 'all the other' firm resources that impact firm fortunes. In particular she argues that resource-based approaches have overlooked both 'pedestrian' resources (which allow the firm to function at a reasonable standard) and more significantly those resources which may in fact have a *negative* impact on firm performance. For example, the negative impacts that result from loss of firm reputation can have more immediate and damaging consequences that outweigh the positive effects of carefully cultivated and deployed resources.

This is a key point, which is partially addressed by Leonard Barton (1992) in her work which examines new product development from a capabilities perspective. In adopting a knowledge-based view of the firm she argues that core competencies may easily become *core rigidities* as project goals or product markets change and past knowledge and

[18] Institutional theory examines the role of social influences and pressures for social conformity in shaping organisational actions.

practice in no longer appropriate.[19] Typically she notes that these rigidities restrict organisations from adapting with sufficient rapidity.

This focus on the best resources and the most successful firms has also created a rather idealised picture of firm achievement. I would argue that it would be more realistic to consider that, a large proportion of firms will be represented by a greater mix of resource attributes. For example identified negative or pedestrian resources may substantially outweigh a smaller number of positive elements. In this respect the literature falls some way short in terms of explaining the differences between firms and would benefit from greater empirical evidence building that extends beyond cases of 'best practice'.

In this move to identify resources Conner (1991), noted that empirical work needed to be cognisant that resources may exist at different levels. She also noted that outcomes, for example, the number of new products to market, were not a good proxy for firm resource success. Accordingly it is more helpful to operationalise the key criteria that resources have to meet to deliver sustained rents. As illustrated above, this may be achieved through analytical categories such as those synthesised by Petraf (1993) or by using Barney's (1991) alternative criteria that resources must be valuable, rare and costly to imitate or substitute.

To date the RBV has tended to focus on individual firms and in many ways this is a positive step based on the tendency towards wider industry analysis that has characterised previous strategy research (see for example, Porter, 1991). So while identifying and understanding the development of resources is key, a firm focus remains important. Nevertheless as Montgomery (1995) suggests, there has been a danger of viewing individual firms as if they exist in isolation. I have already observed that it would be valuable to give greater consideration to institutional factors as highlighted by Oliver (1997). Empirically therefore it would be useful to extend analysis to consider firms more holistically in the context of their competitive and institutional environment. After all, changes in context frequently bring the greatest impacts to the efficacy of a resource bundle.

[19] Rumelt (1995) makes parallel comments with regard to assumptions of plasticity.

2.6.4 Summary

I have shown that strategy research is characterised by eclecticism and controversy. Around some generally agreed heuristics (usually based on Andrews' 1987 framework) there is much disagreement about the nature and interplay of different theoretical schools. Of note has been the ongoing debate between management theory and organisational economics which embraces issues relating to assumptions about human nature, levels of analysis, theories of motivation and the descriptive and prescriptive character of different theories (Donaldson, 1990; Barney, 1990).[20]

Challenges of economic imperialism, remain a popular source of conflict for management scholars. It is therefore interesting that resource-based thinking, with its strong economic heritage has been so widely welcomed and adopted in management research. This may relate to the discrediting of previous strategy work that brought arguably negative changes as many organisations underwent processes of 're-engineering' and 'downsizing' which demoralised workers and damaged some organisations in the long term. Additionally, strategy researchers may have implicitly derived benefit from the robust frameworks associated with economic work even if those with stronger organisation theory orientations were not prepared for the wholesale importation of economic reasoning.

It is clear however that the RBV of the firm and its associated debate has reinvigorated strategy research. At its simplest the RBV focuses on examining resources and capabilities of firms that enable them to generate above normal rates of return and a sustainable competitive advantage. However, as I have indicated the RBV has not followed a necessarily logical path. Mixed contributions and a variety of economic influences have at times, produced a rather disjointed grouping of literature. Work that has sought to produce analytical frameworks from a management perspective has greatly benefited the field (Petraf, 1993; Barney, 1991). Additionally, more critical deliberations and the introduction of potentially synergistic perspectives (particularly from evolutionary economics), have increased the range of issues being deliberated. The

[20] Barney (1990) for example, refutes Donaldson's (1990) challenge that organisational economists are inherently opportunistic in their reading of managerial behaviour suggesting that organisational economics can also embrace notions of trust and altruism. Organisational economics is inherently reductionist but this does not necessarily militate against more holistic assumptions.

development of the 'core competency' and 'dynamic capabilities' concepts have also served to bring dynamic and process elements to the more static economic conceptualisations.[21]

This rapid development has, as observed, created some confusion within the field without necessarily discrediting the credentials or rigour of analytical debate surrounding the RBV. Nevertheless the relative infancy of this work, when compared with existing management and economic theory means that a number of issues require further theoretical and empirical investigation. In this discussion I have highlighted three outstanding areas as being noteworthy.

- First, it was suggested, as argued by Foss (1997), that the RBV has no well developed model of endogenous resource creation.
- Second, inadequate empirical work has been undertaken to consider the existence and impact of 'negative' resources on firm performance (Montgomery, 1995).
- Third, by concentrating on firm level analysis, the RBV has given little attention to the external environment in both a strategic and institutional context (Oliver, 1997).

These issues are developed in subsequent sections as the application of resource-based approaches and their utility for explaining the development of environmental capability is considered.

2.7 An Environmental Context

The opportunities for theoretical extension and empirical testing of resource-based propositions are well served by the changes taking place within organisations as the horizons of the business arena expand to include 'environmental pressures'.[22] The growth of the environmental agenda and accompanying pressures have been extensively explored in contemporary environmental writing from a range of perspectives (McDonagh and Prothero, 1997) and in recent theses examining the interactions between organisation and environment (Bansal, 1995; Stubbs, 1998). The pressures of

[21] Although accusations of lack of rigor have tempered enthusiasm for this work outside the more applied field (Foss, 1997).

'greening' will therefore not be rehearsed at length here, although identified issues will be explored further as they arise in the analysis sections.

It is nonetheless important to indicate that, environmental pressures while previously subject to 'waves' of change, are now more established and endure globally on social, political and economic agendas. Increasingly the literature provides evidence that driving forces are developing to reflect the subtleties and complexities of environmental concern. For example public policy initiatives are set to expand to include, compulsory environmental reporting, the extensive use of new environmental taxation, full financed closure bonds and a mandatory environmental liability regime (Burke, 1999). The development of business to business 'peer' pressures are reflected in benchmarking exercises undertaken by independent research groups (SustainAbility, 1998) and the competition for environmental awards. The blurring of the boundaries between environmentally and socially responsible activity also means that value-laden, ethical issues such as humans rights and employee welfare are increasingly framed within the context of the sustainable development debate. This new agenda places the company as corporate citizen and argues that firms must embrace a new moral contract which characterises the role of the firm as a 'value creating' institution in society (McIntosh et al, 1998; Ghoshal et al, 2000).

While this proliferation of identifiable pressures may arguably represent a crossing of environmental issues into the evolving sustainability debate, the academic agenda remains sufficiently youthful for environmental issues to be considered separately or as an adjunct to the established literature. This is well illustrated in subsequent sections that consider the links between existing management theory and environmental writing. That management writers have been slow to address the implications of growing environmental concern reflects the tendency already observed, of subjects to isolate themselves from interdisciplinary debate. However, it is clear that changes which I will discuss in subsequent sections, have arisen as both the social sciences and management writers have grown to recognise:

- the validity and intrinsic interest of environmental concerns;
- the evolving and enduring nature of environmental pressure;

[22] In this context and throughout this text (unless indicated otherwise) the term 'environmental pressure' has a 'green' connotation. Environmental pressures have also been referred to as 'greening pressures' in other texts.

- the potential issues and opportunities for strategic change;
- the resource and capability implications of engaging with the environmental agenda.

In particular authors have become aware that alongside government institutions and regulatory bodies, it is *business organisations* that are being propelled into the position of environmental manager.

The next section looks first at contributions that derive mainly from the broader but theoretically narrow field of environmental management writing. The prescriptive and mechanical mature of this work is highlighted and I suggest that while useful for mapping the debate in terms of breadth, it has done less to contribute to a deeper understanding of organisational and institutional processes of change that the environmental arena requires. Following this I consider some of the key contributions that have sought to make use of existing organisational theory to understand and explain changes as they occur in the new environmental context. In particular I focus on authors who have used the analytical categories derived by Gladwin (1993) in his call for greater use of extant organisational theory.

The final section returns to the RBV of the firm explored in the first half of this chapter. In doing so I consider, through an analysis of the extant literature, the validity of using resource-based thinking to enhance our understanding of how organisations develop capability and respond to drivers of change in an environmental context.

2.8 The Emergence of Environmental Management

Concern for the natural environment has inevitably led to a growth in environmentally oriented research. Characteristically the focus of study has been driven by disciplinary context so, for example, sociologists have been concerned with environmental values, lawyers have examined the development of regulation and ecologists have considered biodiversity and habitat changes. While significant energy has been put into developing knowledge within the boundaries of a discipline, typically less resources have been directed toward bridging disciplinary divides. As a consequence environmental management literature developed separately from organisational and management writing. A significant proportion of environmental management work has been influenced by the environmental sciences and as such the debate has frequently been of

a technical or scientific nature.[23] These influences are important because in the early stages they guided the paths that organisations took when responding to environmental pressures.

However, by applying knowledge from the environmental sciences in an organisational (usually operational) context, the environmental management literature almost inadvertently started to develop a more interdisciplinary approach. In doing so authors were inclined to 'borrow' from the strategy literature, which as observed earlier, has a tendency to be fragmented and jargon laden. The resulting work incorporated scientific notions of emission levels and environmental burden with the language of management systems and audits.[24] In particular these new ideas were allied to the notion of standards derived from the quality management literature. A retrospective review of the field of environmental management writing distinguishes contributions emerging around three main areas:

1. The sources, and latterly the components, of environmental pressures experienced by business;
2. Models of business responses to environmental pressures;
3. The development of tools and methodologies for environmental management noticeably, Life-Cycle Assessment, Environmental Auditing and Environmental Management Systems.

These three aspects of the literature are reviewed briefly in turn.

2.8.1 Environmental Pressures

The pressures or determinants of greening have evolved considerably over the last decade as the environmental debate has broadened and deepened. In 1993, a survey of environmental managers in the UK, elicited the following perceived environmental pressures (Crosbie and Knight, 1995):

[23] Relating for example to issues such as global warming or acid rain.

[24] See, for example, Welford R (1996), 'Corporate Environmental Management: Systems and Standards', Earthscan, London.

- legislation;
- costs;
- pressure from the financial sector;
- customer reactions, (the general public, supply chain, public bodies);
- community relations.

A more recent review of empirical studies illustrates how environmental pressures have become more complex. Fuchs and Mazmanian (1998) examined 28 studies which either directly, or as an additional consequence of the research, identify the forces behind 'greening'.[25] If these findings are classified, as in Figure 2.6, according to three groupings proposed by Post and Altman (1994), it can be seen how the compliance-based drivers are increasingly incorporating concepts of risk and how value driven concerns are reflected in an expanding stakeholder context.

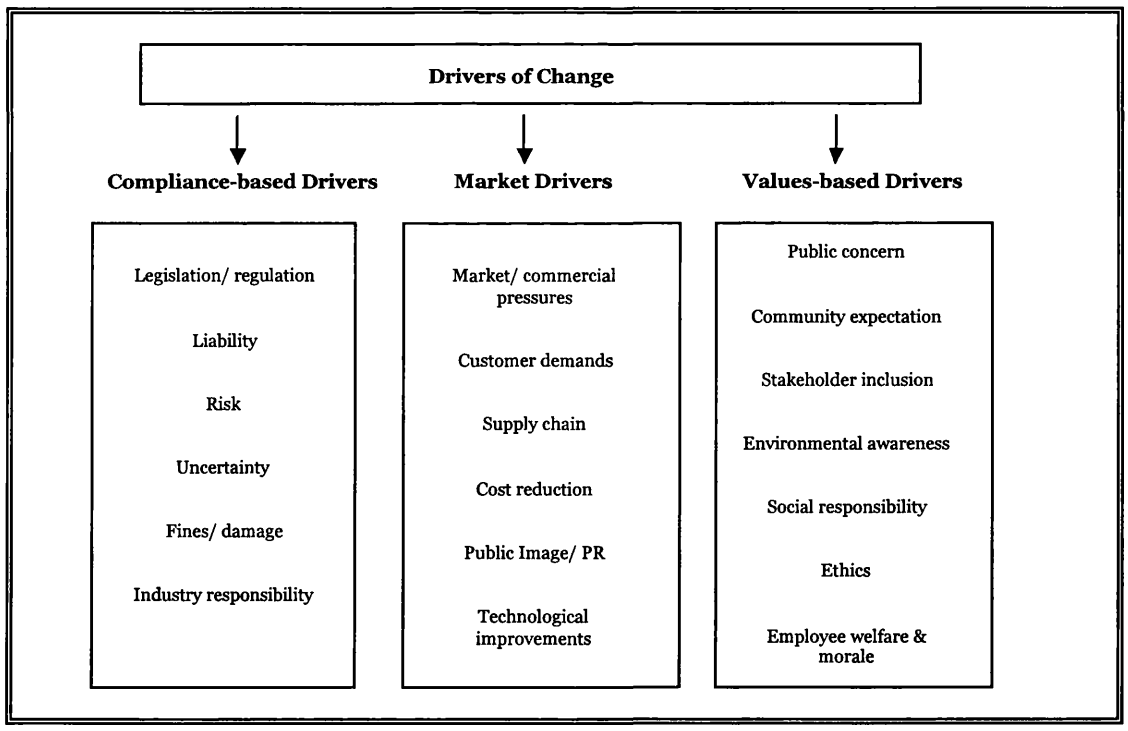

Figure 2.6: The Expansion of Environmental Drivers

[25] The review selection, although not intended to be representative, is certainly indicative as it covers a range of industry sectors including, pulp and paper, chemicals, beverages, tobacco, construction, automobile, consumer electronics, financial institutions as well as a number of surveyed manufacturing and service industries (Fuchs and Mazmanian, 1998, pp. 196-197).

Although by no means inclusive the Figure also illustrates how 'external' drivers are creating 'spin-off' incentives internally for firms. For example social concerns driven by public interest groups may be adopted internally by employees or senior managers. Or market pressures may stimulate efficiency drives capable of bringing economic benefits (Hart and Ahuja, 1996). As Barrett and Murphy (1996) suggest, this changing landscape represents, an interesting motivational mix of opportunity and threat where interpretation is largely dependent on company stance. In their case-based analysis this demanded:

> "... assessing risk to company profitability ... and balancing investment in change necessitated by policy shift against calculated benefits." (Barrett and Murphy, 1996, p. 79)

It is suggested that authors have successfully charted the rise of drivers and made strides to identify and map, through stakeholder analysis techniques, key constituents. More recent assessments of the field have also highlighted how macro level concerns such as sustainability and globalisation are framing and adding new layers of complexity to the debate (Bragdt et al, 1998). However the progression of research from identifying determinants to understanding how important these drivers are in influencing individual firm behaviour, is still arguably in its early phases (Fuchs and Mazmanian, 1998).

At a more generic level though, work seeking to model corporate responses to environmental drivers, has adopted a more analytical stance. In particular, authors have focused on assessing and categorising environmental performance in order to provide pointers and prescriptions for strategy (Bhargava and Welford, 1996).

2.8.2 Models of Corporate Greening

The development of 'models of corporate greening' is a key theme in environmental management writing. The aim of these contributions appeared to be primarily to describe how companies were responding to the identified range of environmental drivers.[26] In their discussion Bhargava and Welford (1996), describe the models which

[26] Examples include Simpsons's (1991) categories, 'Why Me's, 'Smart Movers' and 'The Enthusiasts'. Or Steger's four category model (in Roome, 1994) indifference, offensive, defensive and innovative.

emerged in the early 1990s as theoretical frameworks, a debatable point as the models do not appear to make any explicit attempts to adapt or develop existing theory. It would perhaps be more accurate to describe the models as classification systems, which are useful in their own right, as they help to develop our understanding of complexity (Hass, 1996). By looking more closely at modelling endeavours, it is possible to identify groupings according to structure. As Hass (1996) notes, models either describe a *continuum* of behaviour, for example Hunt and Auster (1990) and Dodge (1997), or are *categorical* (Schott, 1992), see Figure 2.7.

The groupings may take an environmental risk and market opportunity basis (Hunt and Auster, 1990) or reflect an internal perspective of organisational constraints and the ability of management to bring about change (Steger, 1993).

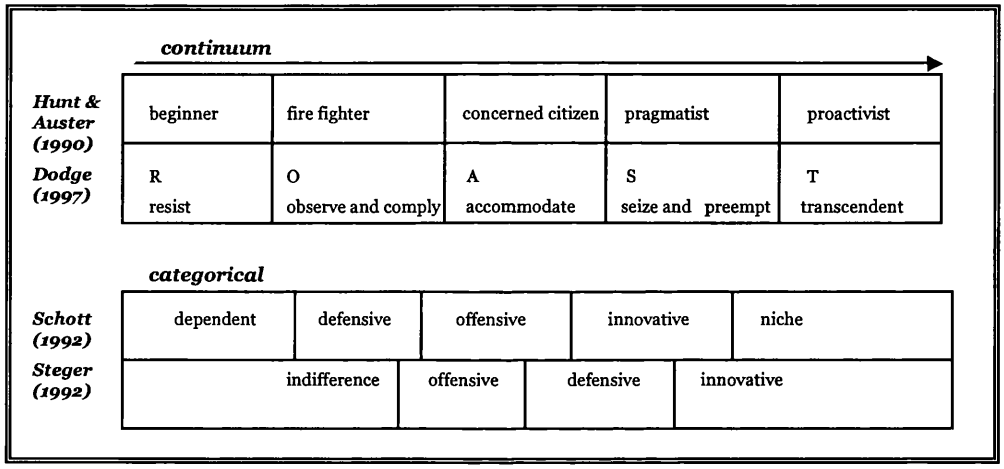

Figure 2.7: Continuum and Categorical Models of Corporate Greening

One of the issues concerning model development is that they have largely been developed conceptually rather than on the basis of empirical information. That is, in the strictest sense they represent typologies rather than taxonomies. As Hass (1992) illustrates in her attempt to operationalise the Hunt and Auster (1990) model, real life scenarios rarely fit the categories or stages delineated by authors. Which suggests that some models are most usefully applied (as noted in a strategy context) as heuristics. Furthermore, these conceptualisations have not always been effectively linked to extant theory concerned with understanding how organisations actually operate and behave in an environmental context. However, several authors have begun to address this issue

Dodge (1997) for example, draws links between positions on his 'ROAST' scale and organisational structure and culture. More significantly Post and Altman (1994) tie their conceptual work to the literatures on corporate responsiveness and organisational learning. They too develop a continuum model but importantly base their categories on findings from empirical investigations. They make the case for transformational change where environmental performance improves over time. It is important to note though, that their model is developed on the basis of best practice cases, and in doing so they effectively limit the applicability of the model in a wider context to organisations in non-compliance or compliance positions.

One of the features, frequently used by authors in an attempt to 'slot' organisations into the model categories is the extent of organisational involvement with the tools of corporate greening. The development of tools and systems for corporate environmental management has been the most successful and prolific source of writing in the environmental management arena. Numerous texts and journals are now dedicated to explaining the paths and pitfalls of corporate engagement in these activities.[27]

2.8.3 The Tools of Environmental Management

An important aspect of the changing business arena, as exemplified by environmental drivers, has been the development of environmental management tools. These tools include :

- environmental audits;
- environmental impact assessment;
- environmental management systems;
- environmental accounting;
- life-cycle principles and practices.

Of this 'toolkit' perhaps the most ubiquitous and widely adopted has been the environmental management system. Formal environmental management systems (EMS) emerged in 1990, when the British Standards Institute, under a request to consider third party assessment of environmental performance, began the development of the first environmental management standard (Starkey, 1996). The systems

[27] See for example, Sheldon C (ed) (1997), 'ISO 14001 and Beyond: Environmental Management Systems in the Real World', and 'Eco-management and Auditing', a journal targeted at the academic/practitioner interface.

developed a structured, cyclical approach to environmental management based on a series of review and feedback mechanisms. In doing so environmental systems 'imported' existing management approaches in particular the Deming Cycle (a process management tool developed in the field of quality management that advocates a system of 'plan-do-check-act'). This methodology was welcomed by several authors who perceived benefits in a quality philosophy and this spawned an additional literature around Total Quality Environmental Management (TQEM) (Shrivastava, 1996).

The popularity of environmental management systems raised the level of enthusiasm and expectation surrounding the benefits that EMS could deliver, ranging from reduced bottom line operating costs to the less tangible gains of improved public perception. Authors reported substantial savings achieved by high profile companies such as 3M and Chevron through systematic waste reduction and pollution prevention efforts (Stead and Stead, 1996; Shrivastava, 1996). Perceived synergies between the processes of achieving quality and environmental objectives were also seen to be beneficial in EMS implementation. Netherwood (1996) for example, suggested that the experience gained by organisations in adopting quality standards could be effectively employed in working towards environmental objectives. Further, bureaucratic burdens could be eased, by merging documentation and responsibilities.

Working towards a certified EMS was also viewed as a mechanism to improve relationships with key stakeholders such as suppliers and customers (Carew, 1996). In particular, it was argued that certification could positively affect an organisation's relationship with the regulator. In the United States for example, it was reported that the Environmental Protection Agency (EPA) would be more lenient with companies who had an EMS, should an environmental incident occur (Sunderland, 1997). The requirement of the standards to set targets and evaluate progress, meant that EMS were the first structured attempt at continual performance improvement in relation to environmental goals, theoretically bringing a new accountability to performance measurement.

However, some of the initial enthusiasm for EMS was dampened by emerging empirical evidence that benefits were not necessarily so universal and continual. Walley and Whitehead (1994), influentially argued that early successes, particularly in cost

reduction reflected the first stages of an evolutionary progression where large gains could be achieved without substantial investment or a necessarily strategic approach. They argued that reported savings merely reflected the capture of classically 'low-hanging fruit' and that paybacks would inevitably diminish over time making investment in environmental management less attractive to managers.

Further, the synergies with quality were increasingly seen as detracting from the dynamism necessary to achieve environmental goals. Authors argued that standards associated with quality systems tended to freeze current practice, rather than encouraging excellence and continuous improvement (Street and Barker, 1995). It was observed that companies implementing systems frequently chose the easiest route to achieve a standard by importing a 'stand-alone' system (Sunderland, 1997). This effectively negated the espoused benefits of business process integration.

Although standards, in particular the International ISO 14001 had been hailed as an achievement in terms of performance and benchmarking opportunity, the standard was seen by many to be tainted. Gleckman and Krut (1997), argued that by failing to consult widely during development (in contrast to the development phases of preceding standards such as ISO 9000), industry had effectively 'watered-down' the requirements of the standard. This criticism is in part borne out by the vagaries of standard guidelines, which as Shayler et al (1994) indicate, provides distinct opportunities for 'environmental tokenism' rather than solid commitment. It also prompts questions surrounding the value of an EMS if one of its central tenets, that of performance improvement, can be easily manipulated. As Young states:

> "EMS standards only prove that an organisation is recognising its environmental impact, not necessarily reducing it significantly." (1996, p. 174)

In spite of these criticisms, there exists sufficient evidence to suggest that organisations have derived value from their investment in environmental management for example, through pollution prevention, increased recycling or a reduction in primary resource use (Stead and Stead, 1996). Nevertheless, when assessed against more challenging objectives, such as the integration of the system into existing management structures or its influence on prevailing organisational understanding of environmental principles, the value derived is harder to quantify.

2.8.4 Environmental Management Literature: Limitations

I have argued that environmental management literature has primarily focused on 'tools and methodologies for greening' as illustrated by the widespread adoption of the environmental management system. This tendency towards prescription has frequently resulted in 'one-size-fits-all' guidelines which ignore both the contextual issues that influence managerial decision making, and the inherent complexity of the natural environment. Those who crafted the system standards were mindful of organisational concerns through the inclusion of organisational structure, training, awareness, competence, responsibility, employee and stakeholder participation as well as the philosophy of continual improvement (Meima and Welford, 1997). However less guidance is given on how to incorporate these concerns into organisational processes.

Therefore, although the literature successfully maps out the territory through drivers and models, it does not address in detail the implications for organisations. In particular, how these new external forces create challenges for existing internal processes and systems. As a result, the literature structurally separates environmental concerns from other managerial aspects of the business. A shortcoming which is perhaps unsurprisingly reflected in an empirical context. As Fineman (1996b) observes, even where companies have devoted resources to a dedicated environmental department, managers report a sense of isolation and detachment, together with a difficulty in communicating with the 'real' workings of the business.

Rather than engaging with management issues, environmental research has 'borrowed' elements from management, in particular the models and rhetoric of strategy. In addition, as contemporary reviews of the field indicate, references drawn from outside environmental writing have concentrated on how external actors and circumstances exert pressure on organisations (Dobers et al 2000), rather than addressing the internal organisational challenges inherent in these pressures.

To date the relatively shallow cross fertilisation of theory means that inevitably the business and environment literatures continue to 'talk different languages' (Wolff, 1998) and that as a result, authors frame environmental challenges from polar perspectives. The environmental literature is biased toward ecologists and engineers who view the environment as an objective problem for which engineered solutions exist.

Management researchers are more likely to view environmental issues as socially constructed. As such they are marred by complexity as well as being value and emotion laden. This suggests that while organisations have solid, physical aspects that can be tackled with systems and audits they also comprise a human element that demands a people-centred approach.

A recognition of the need to engage with the 'softer' more subjective elements of the environmental challenge is now, leading environmental research in new directions (Dodge, 1997; Jones and Welford, 1997). Researchers have begun to consider the implications for organisational culture (Halme, 1997), human resource management (Emerson et al, 1997) and organisational capacity to learn (Barratt and Murphy, 1996). However, the rather scattered and fragmented nature of the debate has militated against the cohesion and continuity that is required for effective theory building. The lack of integration, particularly from a management perspective, has arguably kept environmental writing out of the management mainstream.

2.8.5 Environmental Management Literature: Directions

Attempts to remedy this situation have led researchers to 'reframe' traditional management concerns from an environmental perspective. Shrivastava (1995) was one of the first authors to propose an 'eco-centric management paradigm'. He argued that extant management theory adopted a denatured view of the environment by using a narrow conception of the 'organisational environment' that excluded the natural environment. He further suggested that production/consumption biases needed to be challenged, and that environmental risks (to human health and ecosystems through environmental degradation), should be of equal if not greater concern than financial risk. More fundamentally he argued that deep-seated anthropogenic beliefs inherent in most management perspectives, would continue to see the marginalisation of environmental concerns in most 'business as usual' scenarios.

Gladwin et al (1995) made similar observations relating to the dichotomy between management theorising and ecological thinking. They developed a vision of organisations that is both people-centred and conservation-based. In doing so, they argued that development objectives were only acceptable when subject to constraints such as equity (fair distribution of resources), prudence (protecting life-supporting ecosystems), connectivity (environmental goals cannot be considered in isolation from

social and environmental goals), and inclusiveness (the embracing of human and environmental systems) (Gladwin et al, 1995). Their proposed paradigm is one of 'ecological humanism', which builds bridges between environmental (eco-centric) thinking and the reality of business as it is constructed.

Hart (1995) also argued for a more inclusive conception of the 'organisational environment', suggesting a 'natural-resource-based-view of the firm'. He proposed a conceptual framework of three strategies, pollution prevention, product stewardship and sustainable development, which are seen as being interconnected.[28] Each strategic position is regarded as requiring a series of resources (with specific attributes) as well as external legitimacy achieved through transparency, stakeholder integration and collaboration. Although he supplies an arguably less radical philosophical agenda than other authors, Hart's (1995) framework does crucially provide firm building blocks to address the internal, process issues excluded by environmental writing (discussed further in section 2.11.1).

The concepts introduced by these authors and other notable contributions from an institutional perspective (Jennings and Zanderbergen, 1995; Halme, 1996) have paved the way for a more consistent approach to researching environment-business interactions. Nevertheless, as I show in subsequent sections, much empirical work remains to be undertaken to determine whether propositions made by these authors are applicable or workable in 'real-life' settings. Further, while it is clear that authors have identified shortcomings in adopting a denatured approach to theorising about organisations, the need to green *theory itself* remains open to question.[29] Rather it may be more appropriate as Wolff (1998) highlights, to *apply and adapt* extant management theory to environmental problems as opposed to redrawing theory along ecological lines. It was from this perspective that Gladwin (1993) proposed his, much cited six typologies, see Figure 2. 8.

[28] A framework updated in subsequent writing to include, a green technology phase (Hart, 1997).

[29] Questions that are arguably of a deeper philosophical nature and beyond the scope of this discussion.

- Greening as Institutionalisation
- Greening as Organisational Learning
- Greening as Natural Selection
- Greening as Strategic Choice
- Greening as Transformational Leadership
- Greening as Organisational Evolution

Figure 2.8: Gladwin's Six Typologies

He argued that, while a number of disciplines provided potential theoretical applications, sociological theory pertaining to organisations presented the greatest promise. He critiqued extant research in the environmental field for its:

- poor use of definitions and models;
- lack of cumulative research findings;
- limited longitudinal research;
- tendencies to engage in ideology and advocacy;
- failure to place work into broader research streams and (as I have suggested throughout this section);
- for neglecting rigorous theoretical and methodological foundations (Gladwin, 1993).

Gladwin's contribution may be seen as having threefold importance. First, he highlighted more clearly and persuasively than preceding authors how environmental issues had been neglected in management literature. Second, his article in many ways legitimised what had been until that point, a marginalised topic for management thinkers. Third and perhaps most importantly, he persuasively made the case for the use of organisational theory and in doing so provided, for the first time, a cohesive theoretical platform for writers to apply. The results of authors responding to Gladwin's (1993) 'plea' have in subsequent years emerged as the more insightful contributions towards the understanding of 'greening'.

2.9 Opening Up the Debate

In developing his argument Gladwin (1993) points to the paradox inherent in the greening debate. While addressing environmental challenges is perhaps one of the most important and pressing issues of our time, understanding the processes of greening remains, 'troublesomely ambiguous'. Examining the application and potential contributions of each possible route through organisational theory represents a formidable endeavour (Meima, 1997). The following section extracts a sample of key contributions and draws out linking themes and issues that tie in to the subsequent consideration in this discussion, of competency development and the importance of contextual factors.

2.9.1 Contributions from Organisational Learning

The opportunities to understand the greening of organisations through conceptions of organisational learning are wide. Comprehending change in organisations through a 'learning' lens has become increasingly popular as the turbulence of the business environment grows as a result of technological and new media developments. Additionally, as Dodgson (1993) suggests, learning is a dynamic concept with broad analytical value.

In parallel with our experiences of the youthful environmental literature, learning has drawn from across the disciplines. Learning has long been associated with theories of the firm, first through Cyert and March (1963), who labelled adaptation as organisational learning and more recently (as noted previously) with dynamic conceptions of firm capability (Teece et al, 1990). The basic structure of Cyert and March's (1963) perspective is *external* and the business literature in general has tended to focus on the *outcomes* of learning. In contrast, organisation theory and psychological perspectives in particular, have focused on getting in touch with *internal* processes to explain what is going on *inside* organisations. It is these foundations that authors have used when working towards understanding and explaining changes in an environmental context.

I indicated previously in section 2.8.2, that Post and Altman (1994) employed knowledge from an organisational theory perspective to build their 'Corporate Greening Model'. Their 'environmental performance curve' describes incremental phases of

'adjustment, adaptation and anticipation and innovation' in response to environmental pressures, (Post and Altman, 1994). This transformational change is explained using a threefold typology of learning developed by Argyris and Schön (1978) which involves single-loop, double-loop and deutero-learning.

> "Organisational learning involves the detection and correction of error. When the error detected and corrected permits the organisation to carry on its present policies or achieve its present objective, then that error-detection-and-correction process is single-loop learning. Double-loop learning occurs when error is detected and corrected in ways that involve the modification of an organisation's underlying norms, polices and objective." (Argyris and Schön, 1978, p.3)

Deutero-learning involves reflecting on previous learning episodes and developing new strategies on the basis of past successes and failures. Figure 2.9, illustrates how Post and Altman's three phases relate to this learning progression. Early compliance oriented 'business as usual scenarios' are superseded by polices and goals that challenge and alter core business objectives and structures. In the long term this leads to an institutionalisation of environmental goals coupled with an ability to continually re-evaluate progress (Post and Altman, 1994). The literature has come to define this ability and in particular the motivation to transform and adapt, as characteristic of a 'learning organisation' (Senge, 1990).

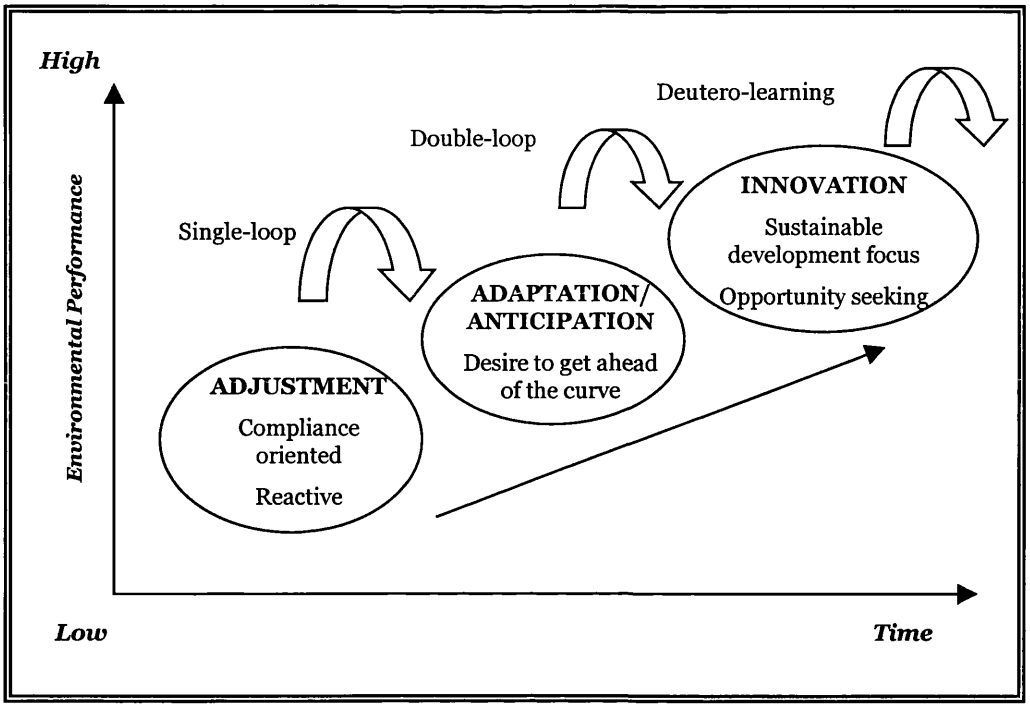

Figure 2.9: The Relationship Between Environmental Performance and Learning (adapted from Post and Altman, 1994).

Neale (1997) builds on this model of learning, in his analysis of Shell's actions in relation to the disposal of the Brent Spar.[30] His analysis indicates that Shell's ability to learn internally was facilitated by organisational features such as consensus decision-making and scenario planning. However, a low capacity to build alliances outside the organisation resulted in 'group-think' when developing solutions for the Brent Spar.[31] Without external support, Shell was forced to rethink existing decision processes and engage in a consultative process that has subsequently led to a public commitment to more active dialogue. Neale's (1997) analysis, shows how an internal examination of company actions facilitated by a learning framework, highlighted the neglect (in this case context) of external actors.

[30] Shell UK's decision to dump at sea a redundant North Sea Oil platform prompted one of the most significant and high profile environmental protests of the 1990s led by the environmental pressure group Greenpeace. The campaign against Shell's actions led to widespread consumer boycotts of Shell's products in Europe.

[31] 'Group-think , a mode of thinking that people engage in when they are deeply involved in a cohesive in-group, when members strivings for unanimity override their motivation to realistically appraise other courses of action.

At a more generic level Moxen and Strachen (1998) also consider the challenges faced by 'green teams' from an organisational learning perspective. They observe that while organisational learning is well researched, relatively few managers have experience of managing learning relevant to *environmental* change. Issues relating to the 'logics' of decision-making and the need to question the continuing relevance of established business practices have not, they argue, been fully addressed in the context of change driven by environmental concerns. For example, data collected by an existing management information system may not be adequate for environmental planning. These potential barriers have their roots in existing organisational norms that may require 'unlearning'. Crucially the authors indicate, as I argue in subsequent sections, that by using learning approaches it is possible to highlight how academic writers have neglected an adequate consideration of *organisational context* in evaluating the development and outcomes of environmental strategies and policies.

Dobers and Wolff (1996) also recognise that it is the specifics of organisational context and their contingencies that need to be addressed. The authors argue that as competitiveness between organisations is increasingly knowledge driven, organisations need to be able to draw on competencies that incorporate environmental understanding. Using a stimulus-response structure for learning situations devised by Weick (1979) they analysed empirical data from a state driven programme of environmental change in Sweden. Their data suggests that as environmental drivers have evolved there has been a gradual change in managerial 'theories in use' and as a result, the strategic response of business. They report that in their sample, the attitudes of top managers have changed to a position where ecological issues are increasingly treated strategically. Although they acknowledge that their analysis is simplified they suggest that the learning observed is illustrative of a progression from single to double-loop learning.

In each case the authors illustrate how using a learning perspective draws the level of analysis closer to the firm. In doing so it is possible to obtain more illuminating detail of *how* organisations are actually changing in response to environmental pressures. Additionally these approaches draw attention to the barriers to greening, in particular issues which are specific to organisational context.

2.9.2 Contributions from Theories of Strategic Choice

Theories of strategic choice place organisations and managers in a purposeful position where actions are aimed at directing, influencing and defining the competitive domain (Miles and Snow, 1978). From this perspective having a strategy means deliberately exercising choice in choosing a particular set of activities to deliver a unique mix of value (Porter, 1998). This tendency towards a systematic planned approach, although most suitable to relatively stable environments, has become increasingly popular in environmental management writing. I noted earlier that environmental writing has chosen to adopt some of the more powerful messages emerging from the strategy literature. In particular, writers have argued strongly for 'win-win' scenarios in relation to issues such as pollution prevention and product development (Porter and van der Linde, 1995).

The widespread endorsement of such 'win-win' scenarios may be explained by several key factors. First, the notion of 'win-win' in relation to environmental issues was popularised by Porter (1991) a writer who was already an influential proponent of strategic choice approaches in the mainstream management literature. Second, strategic choice scenarios are arguably less radical in terms of rethinking the underlying ideology of business. Rather, as some authors have suggested, they focus on promoting a 'green business as usual scenario' (Welford, 1997).[32] Third, presenting environmental strategies as potentially profit-making and risk-limiting has to a degree legitimised environmental management approaches in the context of business.

In his 1991 article in the Scientific American Porter contends that,

> "... the conflict between environmental protection and economic competitiveness is a false dichotomy." (1991, p. 168)

He argues that contrary to popular belief, strict environmental regulation has acted as a stimulus rather than a brake on innovation. Citing examples from Germany in relation to air pollution technology, and the United States in terms of environmental remediation from pesticide damage, he makes the case for turning 'environmental

[32] Welford (1997) coins this philosophy 'eco-modernism' arguing that in this guise business simply adds an environmental dimension to its chosen path of development without having to fundamentally change course. This, he

concern' into 'competitive advantage' through efficiency and cost savings. By presenting a positive business case for strategic choice in an environmental context, Porter invites a more thorough investigation of successful environmental initiatives.

Shrivastava (1995) explores how environmental technologies may become a competitive force. Using 3M's now oft cited, 'Pollution Prevention Pays' programme, he reports how the company completed over 2500 pollution prevention projects in the first 15 years (1975-1989) of operation. With an ultimate aim of zero pollution, the company prevented more than 500,000 tons of pollutants and saved more than $500 million in costs during this period, through a combination of approaches that included process modification and equipment redesign. In a similar vein Stead and Stead (1996) relate how Chevron's SMART (Save Money and Reduce Toxics) programme, produced from its inception in 1986, reductions of 50% and 60% on pollution and hazardous waste respectively. Typically savings were achieved through policy measures that aimed to prevent pollution at source and include environmental criteria in product design. These companies along with other high profile examples such as Procter & Gamble, The Body Shop and Ben and Jerry's chose to transparently link and publicly promote 'green' objectives with profit goals, through publishing environmental policies and environmental reports (Dechant and Altman, 1994).

Examples of planned, proactive environmental change are more readily absorbed by a business audience than the characteristically evangelical exhortations in earlier environmental management writing (Newton and Harte, 1997). However strategic choice approaches have been strongly criticised, most notably by Walley and Whitehead (1994), who suggest that Porter's (1991) argument in particular, is one-dimensional, prescriptive and critically neglects any specific guidance for managers. They argue that the win-win scenarios popularised by strategic choice proponents are in fact very rare, and that managers are more realistically forced into decisions based on a weighting of trade-offs (Walley and Whitehead, 1994). They further argue that up-front investments are not necessarily recovered in the long term, as strategic choice advocates suggest. To support this assertion the authors cite investments by Texaco in environmental compliance totalling $7 billion over five years which will double the company's asset

suggests, is incompatible in the long term with sustainable development objectives, which he argues will provide a more enduring and ultimately profitable future for organisations.

base without providing any guaranteed additional revenue (Walley and Whitehead, 1994, p. 46).

Dechant and Altman (1994), concede that the short-term costs of environmental projects will only, 'probably' be outweighed by long term benefits. The authors are also more insightful with regard to the challenges facing companies that adopt the stance of environmental leadership. They highlight both the management of change (developing mindsets committed to proactive environmental goals) and the management of human resources (training, empowering and rewarding employees) as significant hurdles in strategic choice approaches.

Analysis suggests therefore, that for the firm, seeking competitive advantage through environmental leadership can be a risky strategy. This applies both externally, in view of a relatively uncharted green market-place together with a changing legislative climate, and internally, as leadership demands more radical and rapid organisational change. However, for the field of environmental management generally, the proactive nature of strategic choice has lifted the focus away from a track record of defensive positioning.

2.9.3 Contributions from Institutional Theory

Viewing the greening of organisations from the perspective of institutional theory remains an under-researched area. From an institutional standpoint, a firm's choices are constrained not only by economic concerns but also and crucially, by socially constructed factors such as values, norms and customs (Oliver, 1997). Authors argue that these pressures, which combine political concerns, environmental uncertainty and managerial convention have resulted in the emergence of common structures and approaches (institutional isomorphism) (DiMaggio and Powell, 1991). That is, even though organisations are diverse at creation they tend towards homogeneity over time. These tendencies reflect the need for societal support and legitimacy in a firm's sphere of operation.

Institutional theorists are also interested in the processes by which items become institutionalised (Scott, 1987). Frequently firm activities and actions are maintained even through they no longer produce efficiencies (DiMaggio and Powell, 1991). This suggests that the activity may be infused with value and meaning that is specific to the institution becoming, 'recognised as a part of the way of doing things' (Sims et al, 1993).

Jennings and Zanderbergen (1995) argue that understanding the processes of institutionalisation may bring consensus to the way that 'sustainability' is perceived in organisations. They highlight that current understanding of sustainability ranges from organisational interpretations where sustainability equates to 'effectiveness' to ecological representations where sustainability is allied more closely to the Bruntland definition.[33] If over time the ecological components of sustainability become more recognised and widespread, then sustainability will become more legitimate in society, including business organisations (Jennings and Zanderbergen, 1995).

In her thesis examining 'why firms go green', Bansal (1995) highlights the influence of institutional pressures. Bansal positions her work between the schools of strategic choice and social responsibility and in doing so, draws on key elements of institutional thinking. She argues that one of the major elements influencing a firm's adoption of environmental practices is the need to establish a position of *legitimacy* in the face of societal (legislative, political and social) and internal pressures to conform. In adopting this strategic orientation firms will imitate their industry peers rather than attempting to differentiate themselves; behaviour best explained by institutional theory.

Halme (1996) adopts a broader view of institutional theory in her examination of two Finnish paper facilities. She focuses her attention on the internal elements of the institution, in particular the mental models and shared beliefs of managers in relation to environmental issues, which she refers to as their 'environmental management paradigm'.[34] Her analysis shows that the way environmental beliefs evolved and became established in the organisations differed. For one firm, external pressures (in particular environmental legislation) acted as the main trigger and driving force. In contrast, the second firm saw paradigm changes through the influence of an internal change agent, who acted to accelerate change as external pressures arose. Significantly the institution that had already begun to incorporate environmental considerations into its

[33] The Bruntland definition of sustainability is the most widely accepted and enduring definitions of sustainability. Derived from the World Commission on Environment and Development Publication , 'Our Common future' (1987), it states that sustainable development is, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

[34] The 'environmental management paradigm' is referred to as, "a shared world view consisting of the beliefs, assumptions and values of a particular group regarding the relationship of its activities with the natural environment", (Halme, 1996, p. 98).

'environmental management paradigm' was more able to find answers to environmental questions (Halme, 1996).

Although applications of institutional theory in an environmental context are still rare, studies to date have begun to cast light on the processes and outcomes of change for organisations as they apply in a business context that is increasingly incorporating environmental concerns.

2.10 Lessons from the Application of Organisation Theory

The application of a learning perspective is illustrated clearly by the Shell case study, showing the importance for organisations to constantly re-evaluate internal decision making processes (Neale, 1997). For Shell, a lack of timely responsiveness to external constituents brought financial and importantly reputational costs. Dobers and Wolff (1996) also showed, by using learning frameworks, that an organisation's knowledge base needs to be ecologically competent. This means developing a capacity for interdisciplinary knowledge exchange, establishing inter-organisational relationships and maintaining a value driven discourse. Learning applications also showed, how, if firms focus too exclusively on internal issues, they neglect the importance of organisational context (Moxen and Strachan, 1998).

In contrast, strategic choice theories present a picture of the firm as highly receptive to, and influenced by external pressures. This literature typically strives for an application of environmental methodologies for competitive advantage where first movers pre-empt and influence regulatory change. This belief in the potential of the 'win-win' scenario has arguably pushed environmental management strategy closer to the mainstream of business thinking. Critics of strategic choice approaches have however argued that the prescriptive tendencies of this debate contrive to paint an unrealistic picture and in doing so authors have neglected the 'softer' organisational concerns (Walley and Whitehead, 1994).

Institutional theories introduce an important perspective to studies of greening because they consider both external pressures and internal concerns such as values and beliefs when looking for answers to greening questions. Findings from Halme (1996) and Bansal (1995) lend weight to the proposition I introduced in section 2.6.3, that

combining elements of an institutional perspective with competitive theories of the firm may cast a more holistic light on organisational processes, and in this context, the processes of greening.

The following section considers in more detail how an application of resource-based thinking can help us to understand the processes of change that organisations are undertaking in response to environmental drivers. In addition I consider why, and make suggestions as to how, a strong sense of organisational context should be incorporated into any exploration of the processes of greening.

2.11 Linking Management and the Environment

I have argued that resource-based thinking, while relatively immature in the field of management strategy, provides us with new opportunities to understand how companies develop capabilities. Authors have suggested that when effectively applied these capabilities can become a sustained source of competitive advantage. In addition I indicated that critical analysis has identified a need to address a number of outstanding issues associated with this perspective (see section 2.6.4). I have also shown that the emerging field of environmental management strategy has benefited from the application of organisation theory. In particular, proponents of strategic choice have popularised and drawn the issues surrounding environmental management into mainstream business texts.

The next section makes links between the challenges facing resource-based writers and those working on environmental management and strategy. Exploring firm activity and strategy in an environmental context through a resource-based lens provides an opportunity to make contributions to the development of resource-based thinking, and provides a more detailed understanding of how organisations are growing environmental capability. I begin by reviewing a key article by Hart (1995), 'A natural-resource-based-view of the firm', that develops a conceptual framework and provides the theoretical building blocks for research in this area. Next, I undertake a critical analysis of the extant empirical work that draws on, and is supported by, the propositions developed by Hart. I highlight the key contributions emerging from this work as well as its limitations and outline the opportunities for contributions in this field.

2.11.1 A Natural-Resource-Based-View of the Firm

Hart's (1995) contribution may be seen as a more holistic attempt to harness strategic-choice-oriented theory and address the challenges presented by the natural environment.[35] Hart reinforces the critique made by other writers, who argue that management perspectives have systematically neglected consideration of the natural environment (Shrivastava, 1995; Stead and Stead, 1996). By ignoring the constraints that environmental concerns may generate in the future, he suggests that management theorists will fail to identify potential sources of competitive advantage, for example, lowering costs through minimising wasteful emissions.

In developing his 'natural-resource-based-view' of the firm Hart (1995) draws on existing frameworks and concepts established in the resource-based literature. He reminds us that competitive advantage is sustained by capabilities that rest on resources not easily duplicated or imitated by competitors (Rumelt, 1984). These resources, which may comprise physical and financial assets, employee skills and organisational processes are characterised as being tacit, socially complex, and rare (firm-specific) (Wernerfelt, 1984; Barney, 1991). Hart (1995) argues that for the RBV to remain relevant it needs to address the concept of capability development from a perspective that takes into accounts factors emerging as a result of the environmental agenda.[36]

He achieves this by operationalising the connections between environmental challenges and firm resources through three interconnected capabilities, *pollution prevention*, *product stewardship* and *sustainable development* (Hart, 1995, p. 987). In a subsequent article Hart (1997) expands this capability framework to include *clean technology* producing what he describes as a 'sustainability portfolio'.[37] In doing so the author opens up the 'black box' of the firm speculating theoretically as to the composition of, and connections between, environmentally valuable capabilities

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[35] Hart's (1995) article formed part of an Academy of Management Review, Special Forum on Ecologically Sustainable Organisations, 20 (4). Significantly, this was the first time that such a mainstream, influential journal had brought together articles from this perspective.

[36] The author cites rising world populations, the growth in consumption of fossil fuels, accelerated economic activity and industrial production as key factors impacting the way businesses will be required to operate in order to remain successful and importantly, survive in the future.

[37] Although this element is not discussed in his original theory development, I include it in the summary Figure 2.9, and develop characteristics for this capability that draw their inspiration from the original framework.

(Sharma and Vrendenberg, 1998). For each capability Hart (1995, 1997) establishes key resource requirements and their respective characteristics, which I summarise and expand in Figure 2.10 below.

Capability	***Key resource***	***Resource Quality***	***Resource Characteristics***
Pollution prevention	continuous improvement	tacit transparent	total quality management green teams employee involvement
Product stewardship	stakeholder integration	socially complex	life-cycle assessment cross-functional working
Clean technology	technological innovation	socially complex	design for the environment partnerships/ collaboration
Sustainable development	shared vision	rare, firm-specific	integration of policy and practice 'stretch' targets co-operative working

Figure 2.10: Key Environmental Capabilities (adapted from Hart, 1995, 1997).

In advancing the case for environmental capability, Hart (1995) makes two key points that draw from the RBV and corporate social responsibility arguments respectively. First he observes, as do other authors working from an RBV, that an internal focus highlights how capability development is people rich and therefore firm-specific. As I have shown in earlier discussions, this specificity is often the result of a unique developmental history. Hart (1995) therefore proposes that his theoretical environmental capabilities are interconnected. In essence he argues that there exists a path dependence whereby for example, effective pollution prevention strategies at an operational level pre-empt in a logical way, the emergence of life-cycle assessment techniques for product development and cleaner technologies. However, he also posits that this interconnectedness is not necessarily sequential as this 'learning by doing' is more effectively embedded if these strategies are in fact pursued in parallel.

Second, the author suggests that these environmental capabilities for competitive advantage need to be viewed in a broader context that takes account of the social legitimacy issues brought by relationships with external constituents (Hart, 1995; Bansal, 1995). Specifically, he argues that rather than tempering competitive advantages, an external legitimacy orientation that involves integration and participation with stakeholders beyond the firm, may actually help to enhance and differentiate the firm's position.

Hart's (1995, 1997) theoretical framework sets a significant and prospective agenda for future research, and the author acknowledges that testing the propositions developed will require considerable methodological flexibility (p.1008). Opportunities exist to test the elements of each capability, and empirical work may also provide insights into the overall utility of the framework, as a way of conceptualising capability in the firm. Both firm level and more detailed sub-organisation analyses, for example, of a product development team, may be appropriate in understanding how different aspects of capability are developed.

Following the publication of Hart's (1995) work, several authors have made attempts to analyse environmental activity and performance in the firm through a capability lens. The next section analyses the key contributions from authors who while working in an environmental context have adopted resource-based thinking, a natural-resource-based-view of the firm or who have drawn on corporate capability literature.

2.11.2 Exploring Environmental Capability: Empirical Studies

In exploring Hart's work it is argued that the underlying rationale for adopting and interpreting resource-based views in an environmental context, is a belief that these strategically oriented frameworks provide one of the best opportunities to understand the development of environmentally sensitive policies and practices. As I have noted previously, the notion of performance improvement and possible competitive advantage through environmental excellence has become popular and although supported by a handful of celebrated cases, has remained largely untested.

In one of the first studies attempting to shed some light on the hypothesised relationship between improved environmental performance and strategic advantage, Hart and Ahuja (1996) undertook a cross-sectional study to uncover the relationship

between environmental improvement and financial performance. Emissions reduction data for a one year period (drawn originally from the Toxic Release Inventory[38]) was tested against operating performance data, return on sales, return on assets and return on equity (the dependent variables) using multiple regression analysis. The authors included control variables at the industry and firm level. The results of the study showed a significant and positive relationship between emissions reduction and return on sales and assets.[39] The relationship strengthened in the year following reported emissions reductions, peaking in the second year. Splitting the sample for high and low polluting industries showed this effect to be most significant for high polluters, suggesting that these industries accrued the biggest bottom line benefits (Hart and Ahuja, 1996). The results also suggest that the costs of reducing pollution rarely exceed the benefits. However benefits appear not to continue rise over time, rather they level out over the three years for which the authors obtained data.

The study usefully shows that when studied on a macro level, pollution prevention does appear to pay. There are however, important caveats to this argument. As the authors indicate, the data represents the period 1988-89, which in the context of pollution prevention initiatives, may represent the picking of 'low hanging fruit'. Further the results give no information as to how emissions reduction was achieved, as it is not possible to distinguish between abatement, prevention or clean technology techniques. Hart and Ahuja (1996) therefore suggest a fuller empirical examination that extends the question of whether it 'pays to be green' to a study of particular strategies such as product stewardship as well as more targeted sectoral analysis to differentiate between industry groupings.

Russo and Fouts (1997) also examine the relationship between environmental performance and profitability in their study, which draws explicitly on the principles and components of the RBV. They analyse the environmental ratings of 243 firms[40] against their dependent variable, return on assets, and six chosen control variables

[38] The Toxic Release Inventory (TRI) is a publicly available database of reported emissions of selected pollutants from Untied States manufacturing facilities, required by legislation under the Emergency Planning and Community Right to Know Act 1986 .

[39] The relationship between emissions reduction and return on assets exhibited a longer three year time lag.

[40] Independent rather than self reported ratings which take into account factors such as environmental management system pro-activity, waste reduction measures and environmental expenditure (Russo and Fouts, 1997).

(industry concentration, firm growth rate, firm size, capital intensity, advertising intensity and industry growth rate). The results of regression analysis and further tests for robustness[41] provided support for the hypothesis, that high levels of environmental performance were associated with enhanced profitability, supporting previous studies (Hart and Ahuja, 1996). However, Russo and Fouts (1997) provide a more detailed study in that they also test for the moderating effect of industry context in general, and industry growth in particular.

Industry growth, it is argued, impacts a firm's physical assets and technology, organisational capability as well as intangible factors such as reputation and political acumen. While investing in new pollution prevention technology may be both risky and costly at the outset, the authors argue that in the context of high growth industries, where technologies mature more quickly, firms are likely to see a higher prospective return. They further argue that the organisational capability to innovate is more typical of higher growth industries which tend to be younger and have less hierarchical, bureaucratic structures (Russo and Fouts, 1997).[42] A more 'organic' structure associated with younger industries is, they argue, more conducive to fostering a 'beyond compliance' culture.

Russo and Fouts (1997) also suggest that industry growth rate can impact intangible resources such as reputation and political acumen. Slow growth industries may be hampered by established (possibly unfavourable) reputations.[43] In a growth scenario reputations are still being established and there exists a flexibility in reputation space (Shrum and Wuthnow, 1988) (a situation that favours new entrants to the market who may seek to draw benefits from publicising environmental credentials). The authors also point to the salience of political acumen, which they define as the,

> "ability to influence public policies in a way that confers competitive advantage." (Russo and Fouts, 1997, p. 540)

[41] Which disaggregated available data into a year on year analysis.

[42] This point has interesting implications for the low growth extractive industries that tend to be populated by mature firms, but which also face some of the greatest pollution prevention challenges.

[43] The authors cite the case of Exxon and the 'Exxon Valdez' disastrous oil spill which caused long term reputational damage for the company.

Again they argue that this is an ability which varies according to industry context. Mature industries, tend to follow compliance policies and look to slow the pace of legislative change. In contrast, younger industries focus on technological and organisational solutions that favour the more progressive regulatory regimes characteristic of high growth environments. In essence therefore they point to a situation where high growth scenarios foster a climate that supports the development of capabilities (both physical and intangible) necessary for improved environmental performance. These arguments are supported by analysis of the data and additional tests for robustness, showing that the relationship between firm and environmental performance is strengthened as industry growth increases.

This focus on selected external factors as moderators of the performance relationship extends existing RBV treatments of environmental performance, where the tendency has been to focus on aspects internal to the firm (Aragón–Correa, 1998)[44]. The treatment of environmental pressures as a social concern also relates to Hart's (1995) legitimacy construct, which argues for the inclusion of external factors in developing our understanding of capability development.

The authors reviewed, all consider pollution control and pollution prevention to be important capabilities from a resource-based perspective on the path towards improved environmental performance. However, studies have struggled to differentiate between the effects of the two capabilities when assessing performance relationships. In his cross-sectoral study of Spanish firms, Aragón–Correa (1998) identifies that leading edge environmental firms typically employ a combination of these strategies. Significantly he also shows that less pro-active firms may also successfully use prevention technologies. This finding counters the more speculative inferences from aggregate studies which have tended to point to pollution control mechanisms as being the favoured choice of the less pro-active firm (Hart and Ahuja, 1996).

To tackle this issue Klassen and Whybark (1999) suggest that,

[44] Aragón–Correa, (1998), examines the relationship between strategic pro-activity and natural environment related strategy in a sample of Spanish firms, focusing on the relationship between these two internal elements. He does not consider links to profitability or the potential impact of external moderators.

> "... finding a relationship between the *type* of environmental technology implemented and performance would reinforce the necessity of developing strategic resources" (p. 601, emphasis added).

They argue that most research has been conducted at firm level and in order to understand the relationship between resources and capabilities more effectively research may benefit from considering changes at individual manufacturing facilities. To explore these issues more fully the authors draw on both resource-based work and manufacturing strategy to develop an 'environmental technology portfolio' construct, as illustrated in Figure 2.11 (Klassen and Whybark, 1999, p. 602).

The Environmental Technology Portfolio		
Pollution Prevention Technologies	***Management Systems***	***Pollution Control Technologies***
• structural adjustments that involve fundamental changes to a basic product or primary process	• infrastructural investments that affect the way manufacturing is managed	• structural adjustments that treat pollutants and by-products at the end of the manufacturing process

Figure 2.11: A Typology of Environmental Technologies (Klassen and Whybark, 1999).

The study tests the relationship between the composition of the environmental technology portfolio and plant-level performance through a survey and matched archival data. External factors are controlled for by working in a single industry, furniture manufacture, with a final sample size of 66-69.[45] The results showed that,

> "... as a portfolio was increasingly allocated to pollution prevention technologies, manufacturing performance improved in the areas of cost and speed" (p. 606).

Similarly, a parallel relationship was observed with environmental performance which improved (hazardous pollutants decreased) as more resources were allocated to

[45] The study uses three constructs:

- the environmental technology portfolio – measured using a forced choice instrument across five subcategories of environmental technologies;
- manufacturing performance – measured using the factors of cost, quality, speed and flexibility performance (on a Likert-type scale);
- environmental performance – using TRI data..

pollution prevention. Pollution control and management systems were found not to be significantly related to the level of Toxic Release Inventory substance releases. Crucially, performance worsened as the proportion of pollution control technologies increased. The findings are important as they indicate that strategic resources for pollution prevention can benefit performance over two dimensions, environment and manufacturing. This suggests, as some authors have argued, that knowledge-based skills developed in analogous situations such as Total Quality Management, have a broader application (Barney, 1991; Hart, 1995). However, the study is limited (in common with those discussed above) by the time frame of its data (2 years) and its exclusion of how external forces may influence the selection of particular strategies.

Although Klassen and Whybark (1999) consider the value of capability at a sub-organisation level[46] they make less attempt to break down the elements of the capabilities that they discuss. A significant progression in this field emerges from a study undertaken by Sharma and Vrendenberg (1998) who examine the development of environmentally and competitively valuable capabilities in the Canadian oil and gas industry.

Sharma and Vrendenberg (1998) take up the challenge of natural-resource-based-view propositions by examining the linkages between environmental strategies and the development of capabilities. In addition they set out to understand the nature of emergent capabilities and their competitive outcomes (p. 730). In doing so they adopt a different stance to previous studies, as they look in more detail at the underlying resources that may constitute a significant capability. Their approach involves using a case based, grounded methodology (Yin, 1994; Glaser and Strauss, 1967) which is predicated on an analysis of emergent themes. The authors characterised their case study sample of 7 companies as either proactive or reactive according to their stance in relation to 11 environmental dimensions.[47] To be considered pro-active, companies needed to demonstrate a consistent approach across the dimensions, outside activities demanded by regulation. Consistency was also time-dependent spanning a number of selected environmental events significant to the industry.

[46] Sub-organisational studies of capability development remain rare, with exception of Bowen et al (2001) who discuss the development of environmentally valuable capabilities in the context of supply chain initiatives.

Working from this standpoint, interview data was progressively grouped on a 'themed' basis. In grouping and classifying the data, three labels inspired by resource-based thinking suggested themselves to the authors, stakeholder integration, continuous higher order learning and continuous innovation (Sharma and Vrendenberg, 1998, pp. 737 -738). They also observed that for the two pro-active companies in their sample, these abilities appear to be both firm-specific and path dependent relating strongly to an organisational context that supported,

> "... experimentation and the seeking of opportunities at the business/ natural environmental interface in an efficient and effective manner..." (p. 742).

These findings uphold two of Hart's (1995) hypothesised key resources in his capability framework, stakeholder integration, and continuous improvement (interpreted in this context as continuous innovation).

On the basis of these finding the authors then tested two hypotheses to:

- validate the interview findings and;
- test the resource-based view that the capabilities uncovered could be competitively valuable.

A self-report mail survey of 99 companies provided statistically significant support for the proposition that companies with more pro-active environmental strategies would exhibit greater firm-specific capabilities. The results also suggested that these capabilities explained 'around 51 percent' of the variation in competitive benefits emerging from these organisations (Sharma and Vrendenberg, 1998, p. 748). The results of this study are important as they lend empirical weight to the propositions developed in the natural-resource-based-view of the firm (Hart, 1995). Additionally the grounded approach begins to develop some substance in our understanding of the *composition* of the key resources that support hypothesised competitively valuable capabilities.

[47] Dimension were drawn from the environmental management literature and included factors such as, material use, energy conservation measures, employee environmental training, stakeholder integration and public disclosure.

Although more detailed than previous studies, the authors do not uncover the depth of understanding that could be obtained by a more long term and studied examination at a sub-organisational level. Additionally, by controlling for industry context and in particular, choosing to exclude contextual factors internal to the firm (such as the impact on capability development of contemporaneous strategic initiatives in the firm) they neglect to consider some key potential moderators of resource development.

In contrast to previous studies, Hastings (1999) seeks specifically to explore how external contextual factors have influenced the development of new internal firm capabilities in an environmental context. Using data from the oil industry in Latin America, Hastings (1999), analyses the emergence of new ways of working developed by three major companies, ARCO, Amoco and Royal Dutch/ Shell. Hastings argues that key historical issues and new modern socio-political pressures have combined to force a re-think of the companies' 'operational paradigms'. A history of distrust resulting from disputed property rights, loss of indigenous wealth and damage to fragile ecosystems has impacted these companies' licence to operate. These antecedent factors have been intensified by new global media pressures, the increasing empowerment of indigenous groups and more stringent legal restrictions (Hastings, 1999). As a result companies have had to develop new policies and practices to maintain their 'right to operate'.

Hastings (1999) observes that this new paradigm consists of a number of key elements which relate particularly to the need to consider sensitive environments.[48] The elements of Hastings's paradigm are illustrated in Figure 2.12. She proposes that the capabilities she identifies are analogous to Hart's (1995) framework, and on this basis speculates that they may be capable of providing future competitive advantages. However, the author does not provide data to support this assertion, and therefore in this context, the relationship remains unproven.

[48] The author does not provide an indication of data collection techniques. It is inferred from comments in the text that interview, observation and secondary data analysis was used. The elements or criteria of Hastings's proposed capabilities appear to be drawn from a combination of case relevant literature and analysis of case material.

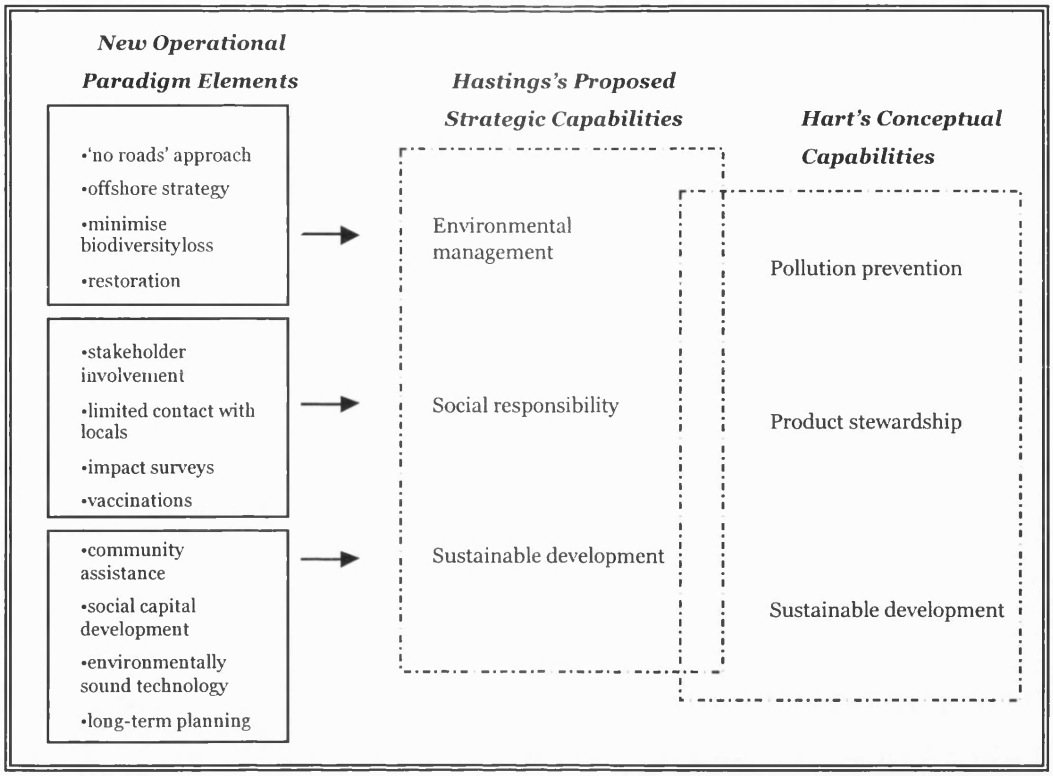

Figure 2.12: Paradigm Elements and Strategic Capabilities (Hastings, 1999).

The presentation of evidence that a new operational paradigm precedes the development of environmentally and competitively valuable capabilities is however significant. These findings echo work undertaken by Halme (1996) in the Finnish paper industry (discussed in section 2.9.3). Specifically she identified that as a result of key changes in the firms' institutional context, the businesses began to reconstruct their relationship with the natural environment. Halme's (1996) description of changes mirror some of the issues that Hastings (1999) identifies, such as regulatory reform, biodiversity concerns, and the politicisation of stakeholder interests.

These findings are important because they contribute to the relatively under-researched area concerning how businesses are responding to changes in institutional pressures in an environmental context. The focus on external factors also adds value to Hart's conceptual framework. Although the analytical opportunities presented by the natural-resource-based-view are not fully explored in Hastings' study, I would argue that it does add weight to the notion that value may be gained from considering environmental change in organisations from a combination of resource-based and institutional

perspectives as proposed in earlier discussion. As the inter-relationships and relevance of the strategic capabilities in Hastings' study remain untested it may be useful, as she suggests, to investigate how other extractive industries 'fit' into the natural-resource-based-view of the firm. This is an issue that I develop further in chapter three (section 3.2).

Although Hastings (1999) considers internal changes in the firm by identifying her 'new operational paradigm', her focus is driven primarily by changes in institutional context. I have suggested that there may be value in considering more closely the interaction between these external factors and the capability-enhancing resources, which constitute the capacity of the organisation. In their study of two small metal fabrication firms in the United States, Marcus and McEvily (1999) begin to bridge these issues in their study of environmental competence.[49] Drawing on studies of corporate capability (Barney, 1991; Wernerfelt, 1984; Prahalad and Hamel, 1990) and learning and innovation, (Cohen and Levinthal, 1990) they argue (as I discussed in section 2.6) that the process of competence acquisition has not been thoroughly investigated and is therefore not well understood. In particular they argue that,

> " ... consideration should be given to a firm's *capacities* to assimilate and exploit new knowledge ... and to the social and institutional *context* in which a firm is embedded ..." (Marcus and McEvily, 1999, p. 291, original emphasis).

Their study consisted of interviews with the firm's owners or chief executives as well as interviews with firm constituents, including suppliers and customers. The interviews and analysis were framed around predetermined factors for capacity (competitive strategy, size and degree of professionalism, past experience with innovation) and context (suppliers, customers and other external linkages) (Marcus and McEvily, 1999). Analysis showed that the two firms, which faced the same compliance pressures, had significantly different approaches when viewed from these set criteria.

The larger organisation[50] was observed as being more open to 'trial and error' in innovation, which they suggest, may be due to greater resources and a wider degree of organisational slack. However these factors alone do not sufficiently explain greater

[49] As noted previously, the terms competence and capability are considered synonymous in this discussion.

[50] In the sample the larger organisation had 75 employees and the smaller company had 8.

innovative tendencies. The authors posit that, in this context, the ability to innovate, was for this organisation enhanced by an established, close working relationship with suppliers. Sharing both knowledge and the costs of innovation with suppliers sanctioned the larger firm to take risks. This open outlook also allowed the firm to view new environmental regulations as an opportunity to master new processes (Marcus and McEvily, 1999, p. 302). In contrast the smaller firm lacked the experience of partnership working and the knowledge gained through these activities, appearing reluctant to push suppliers for new information. They viewed new regulation as an obstacle, preferring to avoid process changes through regulatory 'loopholes'.

While neither company considered customers an important source of information, the larger company exhibited a wider external network of linkages. A diversity of ties spanning professional organisations and direct firm-instigated contact with environmental pressure groups, meant that the company was aware of industry and social change. The smaller firm restricted its contacts, relying on internal and family connections, reacting to, rather then pre-empting changes in a social context (Marcus and McEvily, 1999).

This study, while conducted on a small scale, in small organisations, nevertheless flags some of the resources that Hart's hypothesised framework considers key, stakeholder integration, technological innovation and partnership working. The authors appear to suggest in their analysis that acquiring a competence in for example, cleaner technology, relied on an interaction between factors internal to the firm (such as experience with innovation) and factors in the firm's external context (supplier partnerships) (Marcus and McEvily, 1999, p. 292). This again supports Hart's (1995) external-legitimacy-oriented construct and the directions suggested by Hastings' (1999) analysis.

The study integrates elements of capability development and context, that I have argued need more comprehensive coverage in order to improve our understanding of environmental competence. The application of these findings is limited however, by the size of the data set and the depth of investigation. In particular, there is now a significant literature (Hillary, 1997; Tilley, 1998) that argues for a separate treatment of

business and environmental issues in small and medium sized organisations. Although it is possible to generalise to theory from case study research, it would be unwise to abstract too broadly to larger organisations from a firm of this size.

2.11.3 Summary

In the preceding section I reviewed and analysed the key contributions from authors working in an environmental context who draw theoretical contributions from the RBV and corporate capabilities literature as well as elements of organisation theory. The salient contributions of this literature are summarised in Table 2.5. I have argued that, when considered collectively, this work has started to open the debate in the area of environmental management strategy to more comprehensive and rigorous analysis.

The next section evaluates these contributions in terms of our ability to address outstanding issues relating to resource-based thinking and environmental strategy. I continue by setting out a series of potential research directions to be focused through relevant research questions (in chapter three) that aim to expand and supplement this new area of strategy research.

Table 2.5: Empirical Studies Identifying Environmental Capability

Authors	Study Subject	Sample	Study Type	Level of Analysis	Literature	Resources / capabilities identified
Dobers and Wolff 1996	Managing the Learning of Ecological Competence	- local government project , Sweden	- case study - interviews and secondary data	- project	- business strategy - organisational learning	Capabilities: - interdisciplinary scientific knowledge base - inter-organisational relationships - technological integration - value driven discourse
Hart and Ahuja 1996	Empirical Examination of the Relationship Between Emission Reduction and Firm Performance	- 127 firms in manufacturing, mining and production, in the US - data from one year period	- statistical sample from Standard and Poor's 500 list of corporations & secondary data - hypothesis testing	- firm	- resource-based view	Capabilities: - pollution prevention
Russo and Fouts 1997	A Resource-Based Perspective on Corporate Environmental Performance and Profitability	- 243 firms spanning all industrial classifications, in the US - data from two year period	- statistical sample from published environmental ratings database (Franklin Research and Development Corporation) & additional secondary data - hypothesis testing	- firm	- resource-based view - corporate social responsibility	Capabilities: - environmental compliance - pollution prevention - Resources: - reputation - political acumen
Sharma and Vrendenburg 1998	Proactive Corporate Environmental Strategy and the Development of Competitively Valuable Organisational Capabilities	- 7 oil and gas companies, Canada - 99 oil and gas companies, Canada	- case study - interviews and secondary data - theory development - survey - hypothesis testing	- firm - industry	- resource-based view	Capabilities: - stakeholder integration - continuous higher order learning - continuous innovation
Marcus and McEvily 1999	Environmental Competence in Two Small Firms	- two small metal fabrication firms in the US (75 employees max.)	- case study - interviews & secondary data - theory development	- firm	- corporate competencies - innovation management	Capabilities: - technological innovation - technological collaboration - partnership building

Table 2.5 cont. Empirical Studies Identifying Environmental Capability

Authors	Study Subject	Sample	Study Type	Level of Analysis	Literature	Resources / capabilities identified
Hastings 1999	Analysis of Social Pressure, Corporate Capabilities and Competitive Advantage	- three multinational oil companies, (ARCO, Amoco, Royal Dutch/ Shell) in Latin America	- case studies - interviews & secondary data - theory development	- firm	- corporate social responsibility - resource-based view	Capabilities: - environmental management - social responsibility - sustainable development
Klassen and Whybark 1999	The Impact of Environmental Technologies on Manufacturing Performance	- 69 manufacturing facilities, furniture makers in the US	- survey , interviews and archival data - hypothesis testing	- sub-organisation (plant level)	- resource-based view - manufacturing strategy	Capabilities: - pollution prevention - pollution control - management systems
Bowen et al 2001	Explaining the Implementation of Green Supply Initiatives: The Role of Supply Management Capabilities	- 24 business units within UK PLCs (including manufacturing, retail, and extractive)	- interviews and survey - hypothesis testing	- sub-organisation (business unit)	- corporate capabilities - environmental performance - purchasing	Capabilities: - green supply Resources: - cross-functional team working - partnership approach with suppliers - environmental literacy - technical skill of purchasing professionals - established purchasing policies and procedures

2.12 Evaluating Contributions from the Extant Literature

In the preceding section I showed how authors have begun to tackle some of the issues and challenges introduced by Hart (1995) through his natural-resource-based-view of the firm. However, I also suggested that a number of significant topics remain outstanding and as such these ventures into this new branch of strategy represent only the first stages of development in an under-researched field. The following sections highlight the limitations of work to date and summarise the key outstanding issues.

2.12.1 Theoretical and Conceptual Development

In developing their analysis, authors have predominantly chosen to explore the concept of environmental capability at a firm level (see Table, 2.5). As a result the activities of the firm are considered as a whole, or as compared with other organisations. Limited detail therefore emerges about, how, or from where inside the firm, strategic capabilities originate. This means that analysis has also tended to be at the level of the capability, rather than focusing on the underlying resource elements, which Barney (1991), suggests as being the useful level for analysis and development of resource-based perspectives. This lack of focus on the *resource* as the unit of analysis means that authors have not made use of the empirical framework that Barney (1991), (and Hart, 1995 adapts) to identify resource attributes, or what I have termed resource qualities (see Figure 2.10). The only authors to consider the qualities of firm specificity and rareness, do so in conjunction with an aggregate capability (stakeholder integration and continuous innovation) rather than the underlying resources (Sharma and Vrendenberg, 1998). This is potentially confusing as it fails to follow a logical path between *resources*, their key *attributes* and the *capabilities* that they support. This suggests that the level of detail that will provide answers to resource-based questions requires work at a sub-organisational level.

However, the studies to date which are conducted at a sub-organisational level either fail to make these distinctions e.g. (Klassen and Whybark, 1999) or only partially make them e.g. (Bowen et al, 1999). This suggests that a more detailed analysis is required that looks to distinguish and make the connection, between the *stages* of capability development and capabilities themselves, as they are proposed in a resource-based conceptual framework.

Most studies have tended to control for industry context, either through specific variables (Hart and Ahuja, 1996) or by working within national boundaries. In contrast Hastings (1999) explicitly explores the impact of external contextual factors on capability development highlighting the impact of both historical and contemporary factors. Her analysis suggests that these issues had a significant part to play in the development of a new operational paradigm (elements of which may be seen as analogous with resources). This submission is in part supported by the findings of Russo and Fouts (1997) who make a significant empirical link between capability development and the moderating effect of industry context and growth. They indicate that rather than controlling for industry context, future research should explicitly seek to understand the impacts of industry contextual factors on the development of supporting resources.

Additionally, within-industry performance variations as shown by Sharma and Vrendenberg (1998) and Klassen and Whybark (1999), suggest a proposition that contextual factors *specific* to the firm may play an important moderating role in resource and capability development. Indeed, Sharma and Vrendenberg (1998) conceed that their analysis does not take into account that other organisational activities and/or contemporaneous strategic initiatives may in fact be responsible for some of the capability developments that they witness. Issues which again, require a sub-organisational perspective.

The value of the RBV and the potential utility of Hart's (1995) framework (as discussed previously, and illustrated in Figure 2.10) is confirmed by its wide use in the studies reviewed. However, it is not thoroughly critiqued and the detail remains largely untested by authors. As noted above, studies have tended to concentrate at capability level rather than investigating whether characteristics such as employee involvement or green teams really can be identified and confirmed as important resource building blocks. The framework has however, been widely used as a device in which to 'slot' comparative or analogous data. In some instances, on the basis of comparative data (Hastings 1999), authors adopt Hart's propositions relating to competitive advantage without these claims being empirically substantiated. Therefore, particularly at an organisational level, these propositions remain untested.

By concentrating on a particular capability, predominantly pollution prevention, authors have not explored the elements of interconnectedness and path dependency that Hart (1995) suggests may characterise a portfolio of environmental capability. Although some studies begin to touch on this area by examining groupings of capabilities (Klassen and Whybark, 1999), there would appear to be opportunities, particularly in the context of innovation and product stewardship (a proposed strategic environmental capability) to explore some of the issues raised by these propositions. An analysis of the literature suggests that although authors have considered these issues in mainstream innovation, they have not been fully explored in the context of environmental initiatives (Clarke and Pitt, 1996; Winn and Roome, 1993).

2.12.2 Methodology and Methods

Drawing from the discussion and an examination of the summary Table 2.5, it is clear that most authors have chosen to undertake survey-based analyses. These studies draw on large sample sizes, either across industry sectors (Hart and Ahuja, 1996; Russo and Fouts, 1997) or within a particular industry grouping (Sharma and Vrendenberg, 1998; Klassen and Whybark, 1999). In a cross-industry study it is not possible to distinguish effectively, differences or similarities between sectors at a sub-organisational level. Typically this research has tended to develop generic typologies for corporate environmental responsiveness and does not provide insights into individual or organisational particulars (Sharma et al, 1999). Therefore, while findings that 'pollution prevention may pay' can be useful at a generic level, a targeted sectoral analysis is required (Hart and Ahuja, 1996).

Work that has concentrated on a particular industry sector contributes a more detailed perspective to the broader studies. For example, Hart and Ahuja (1996) argue that higher polluting industries may see greater benefits from pollution prevention work. Yet Sharma and Vrendenberg (1998) illustrate (how even where this relationship holds true) that strategy and performance can actually vary widely within a 'high polluting' sector such as the oil and gas industry. Klassen and Whybark (1999, p. 611) also make reference to these intra-sector disparities in the context of the furniture manufacturing industry. Additional information gleaned from site

interviews showed that innovation and investment in process improvements (in their sample) resulted in varying efficiency improvements and waste material reductions (Klassen and Whybark, 1999, p. 611). These findings suggest that, on the basis of established relationships, there is a need for a more detailed investigation of *specific firm* strategies in order to understand these variations.

Empirical studies have illustrated to date that survey data has provided important supporting evidence for hypothesised relationships between environmental capability and strategic advantage. However, these instruments frequently rely on adapted database material not originally designed for the analysis being undertaken. This reduces the researchers' control over the data and invites statistical manipulation that may affect the validity of findings. In addition research that relies on surveys alone is subject to the inaccuracies and disadvantages inherent in self-report instruments.[51]

Concerns regarding data collection are not necessarily resolved by employing interviews, which is the predominant collection method in the case studies reviewed (Hastings, 1999; Marcus and McEvily, 1999).[52] Unfortunately in these instances the authors do not indicate the number of interviews undertaken which makes a comparison and evaluation of the findings more difficult. The empirical findings from these cases are primarily supported with reference to secondary data and conceptual frameworks, which is a valid approach for case studies.

A more balanced perspective may be seen where authors have combined research instruments to develop and then investigate propositions. Two of the studies analysed (Sharma and Vrendenberg, 1998; Bowen et al, 2001) use a combination of interview and questionnaire instruments. This arguably provides both detail, in terms of the depth derived from interviews, and the benefit of an overview from questionnaire data, which is useful for broader comparisons. These mixed methodologies also answer Hart's (1995) call for methodological creativity and point towards a more

[51] Self-report questionnaires usually employ closed questions, are inflexible and the researcher has limited control over the identity of the respondent (Robson, 1993).

[52] Interviews as a research instrument carry their own disadvantages such as researcher bias. These issues are discussed more fully in the methodology chapter.

pragmatic empirical approach that could be usefully extended and developed in this context.[53]

Most of the studies considered have been conducted over a limited time frame, or employ data covering a short (1–2 year) period. This is an acknowledged weakness (Russo and Fouts, 1997), with authors agreeing that studies of capability development would benefit from a longitudinal approach. The exception in this sample is the work of Sharma and Vrendenberg (1998) which was conducted in three phases and involved revisiting interviewees over a study period spanning beyond 2 years. The detail elicited in this work, in particular of the elements underlying capability development, illustrates the applicability of extended study. Additional and complementary longitudinal studies would be of significant value in the emerging and evolving field of environmental capability. Explicitly incorporating dynamics into studies of greening, through longitudinal research that builds on previous work would answer one of Gladwin's (1993) major concerns about progression in the field.

It is interesting to note that the most prominent and influential studies in this field have emerged from the United States. As a consequence most empirical data investigating natural-resource-based propositions draws from American experiences. There is, therefore, a dearth of material exploring change in a European and UK context that takes account of the differing regulatory, social and political processes that mark out the influential elements of nationality. This suggests that contributions may be made by studies working in an environmental context, which compare and contrast experiences across national divides.

I have noted that only a few studies have chosen to use mixed methods and most reflect a methodological tendency towards deductive, hypothesis testing. This is clearly important as there is a need to conceptualise our examination of data in order to form ideas and notions about the phenomena being studied. The only study examined which includes a more inductive approach, is that of Sharma and Vrendenberg (1998) who in the interview phase, use a grounded methodology,

[53] Mixed methodologies and the views of the 'pragmatist' are discussed in more detail in the methods and methodology chapter.

allowing themes and issues to emerge from the data before considering theoretical appropriability (which they then go on to test). However in combing methods, the authors appear to acknowledge that it is difficult to de-couple data from theory. Clearly few authors to date have looked at how to actively combine these research processes. Some authors now argue that, in studies of greening, there may exist opportunities to link evidence and social theory in a more dynamic way (Saether, 1998).

2.12.3 Outstanding Issues

The preceding evaluation of the extant literature suggests that a significant amount of empirical work remains to be undertaken that explores the development of environmental capability in the firm. From this discussion the following issues are highlighted as outstanding.

Theoretical and Conceptual Development

- insufficient analysis that uses a logical framework to assess the relationships between a resource, its attributes, and the resultant capability;
- no systematic investigation or supporting evidence of how external contextual factors impact and potentially moderate resource development;
- incomplete consideration of how non-environmental organisational strategies and factors internal to the firm, impact the development of environmentally valuable resources and capabilities;
- limited critical assessment of Hart's (1995) natural-resource-based-view conceptual framework;
- no exploration of the relevance of path dependency and interconnectedness.

Methods and Methodology

- no single case, depth studies detailing the specific experiences of the firm;
- few studies using sub-organisational units of analysis;
- insufficient longitudinal examinations of capability development;
- no studies comparing and contrasting UK and US experiences;
- limited work using mixed methods and methodologies.

2.13 Chapter Summary

This chapter has critically reviewed and analysed the key areas of literature that underpin the research directions developed in the next chapter. I have argued that attempts to study and develop improved environmental management have been hampered by a lack of supporting theoretical foundations. Throughout the 1990s, a significant proportion of the emerging environmental management literature has been driven by a series of discussions focused around tools, indicators and models. While potentially useful in their practical application, the 'tools' of corporate environmental management have been hampered by a limited understanding of how environmental strategy initiatives may fit with existing organisational processes.

Additionally, by choosing to draw on the field of strategy, the environmental management debate has fallen prey to prescriptive approaches characteristic of strategic management texts. By doing so, authors and practitioners have until recently, failed to address organisational issues such as culture, values and environmental awareness that it is increasingly argued, are an integral part of successful long term environmental management.

I have argued in the review that the growth and development of resource-based perspectives has benefited the discussion surrounding strategy and also provided useful conceptual building blocks for understanding the processes of organisational change as they occur in response to environmental 'greening' pressures. Further I have suggested that contributions complementary to this approach may be sought

from organisation theory. Examples of organisation theory applied to environmental questions are illustrated in the discussion.

More specifically I have put the case for a more detailed investigation of how resource-based perspectives in combination with elements of organisation theory may inform our understanding of the processes of development and the subsequent emergence of environmental capabilities in organisations. An analysis of the limited work to date in this area suggests strongly that opportunities exist to progress knowledge in this field. In the next chapter I develop a series of research propositions that draw on the foundations constructed in this chapter.

Chapter Three: Research Directions

3. 1 Introduction

In chapter two I demonstrated that resource-based perspectives provide a useful platform for examining the changes in organisations that may be occurring as a result of the broadening environmental agenda. The evaluation indicated clearly that significant work remains to be done, both in terms of testing the value of proposed frameworks, and in extending analysis in a way that encompasses the use of complementary theory. The next five sections take the preceding discussion forward by developing in more detail the research directions. Drawing on key observations from the literature, I isolate the elements to be studied and indicate how the research is to be directed through a series of propositions.

First I make a brief case for the chosen context[1], and in doing so I argue that the nature of the selected industry suggests analysis be focused on two particular capabilities, pollution prevention and clean technology. The next two sections 'unpack' the resource characteristics that underlie these capabilities. Examples from the literature indicate why these characteristics may be important in capability development and therefore warrant further investigation. The fourth section introduces the concept of 'moderators' and argues that selected factors internal to the firm can impact the development of resource characteristics. Finally, I outline how incorporating an understanding and analysis of key elements of an organisation's institutional context can assist in providing an assessment of environmental institutional capital (Oliver, 1997). It is proposed that such capital is a necessary constituent in the development of environmental capability.

3.2 The Research Context

In the summary section of the previous chapter, I indicated that opportunities exist to build on established empirical findings in the extractive sector. The close environment-industry relationship of this sector provides a favourable empirical testing ground for examining the development of organisational environmental capability.

[1] The details of the chosen industry, its business and environmental context are described more fully in the case context chapter five.

At a generic level, any industry that exploits non-renewable resources is inextricably linked to questions surrounding resource exploitation and environmental damage. Hutchinson (1996, p. 15) classifies the extractive sector as high penetration, describing industries in this grouping as 'damaging, dirty and dangerous'. This immediate and potentially deleterious relationship with the environment makes extractive industries conspicuous through their physical site operations, and more indirectly, through the issues that emerge as a result of their operational activities. Being highly visible, either as an organisation or through the issues that your activities generate, is particularly relevant for extractive industries. High visibility, whether it is associated with brand or with actions taken by an organisation, frequently results in companies becoming more exposed to social pressures[2] (Bowen, 2000a). Evolving environmental pressures, which I identified in chapter two as being increasingly multifaceted, have become an important component of contemporary social pressure and are therefore of particular relevance to these industries.

I have shown that previous resource-based studies in the extractive sector have focused on capability development in the oil and gas industry (Sharma and Vrendenberg, 1997, Hastings, 1999). The empirical choices in these studies were justified primarily through the rationale outlined above. However, the extractive sector encompasses a significantly wider grouping of businesses, which is arguably dominated by metals and mineral mining enterprises. Companies undertaking the winning and working of minerals are equally subject to pressures from a wide range of constituents. Of particular note have been regulatory changes and the movement towards more stringent environmental standards both nationally and internationally (Warhurst, 1994).

Previous studies examining changing practices in the mining industry as a result of environmental pressures have made reference to the need for capability improvements (Warhurst and Bridge, 1996). However, work at the mining-environment interface has tended to focus either on specific environmental pressures, in particular regulation, or on more the technical aspects of any change process. As a result, less attention has been given to the managerial, resource and capability implications of changes implied by environmental drivers.

[2] Bowen (2000a) offers a detailed discussion of how the elements of visibility may drive, and in future serve to predict, levels of environmental response in firms.

Most mining projects undergo three main phases, exploration, mineral extraction and operation, and closure. While environmental impacts are inherent at each stage, the most significant concerns arise during operation and at the end of the mines' useful life. Pressures from the market to produce more efficiently (Crowson, 1997) and from social and regulatory concerns to minimise the environmental damage of operations, point to a key role for *pollution prevention* capabilities during the extraction and processing phases.

Concerns for competitiveness in product costing and improved quality have led to incremental technological innovations in the mining industry (Crowson, 1997). Warhurst and Bridge (1996), argue that environmental concerns can also act as a spur to innovation and that progress towards improved environmental performance in mining firms is beginning to displace the industry's reputation for technological conservatism. Improvements in quality that enable a firm to be more efficient and competitive in the market-place have clear synergies with cleaner production techniques that seek to generate less waste and pollution. The opportunities to improve environmental performance through innovation in process and product techniques point to the potential competitive significance of an established capability in *clean technology*.

At a macro scale it may therefore be argued that the concerns of a mining enterprise relate closely to other companies engaged in extractive activities. This indicates scope for contributions and tentative comparisons at a generic level that may inform our understanding of the sector as a whole. More specifically however, the opportunities provided by focusing on a new industry in this sector, include a more detailed assessment of the two identified constructs in Hart's (1995, 1997) framework, pollution prevention and clean technology which may facilitate contributions at a theoretical level.

3.3 Identifying Resource Characteristics: Pollution Prevention

In the analysis of Hart's (1995) natural-resource-based-view of the firm (chapter two, section 2.11.1) I attempted to classify in a more systematic way resources and the contributory characteristics and qualities which underpin a proposed strategic environmental capability. I have argued in my evaluation of the extant empirical literature that to date, studies have, with a few notable exceptions (Sharma and Vrendenberg, 1998), focused almost exclusively at the level of the capability. In particular, work has been directed at examining the link between a proposed capability and the potential cost:benefits or competitive advantage of its application. I have suggested that in doing so authors have failed as Barney (1991) argues, to examine the relationship between the attributes (qualities and characteristics) of a proposed resource and the emergence of the hypothesised resultant capability. While a significant number of authors have drawn heavily on theoretical notions of resource qualities, e.g. that they are tacit, causally ambiguous and socially complex, few have attempted to identify the more tangible *characteristics* of resources that may be investigated empirically.

Hart (1995, 1997), takes a significant step towards developing a framework that may be empirically investigated by identifying what he considers to be the potential underlying elements of a key resource (which I have termed characteristics). Hart (1995) suggests that a pollution prevention capability is supported by the key resource of continuous improvement. In an adaptation of Hart's (1995) analysis I have suggested that this key resource is in turn 'characterised' by a number of key elements, which in his discussion Hart (1995) proposes may be Total Quality Management (TQM), 'green teams' and employee involvement. Each characteristic is considered in more detail below.

3.3.1 Total Quality Management

Total Quality Management (TQM) was conceived and popularised by consultants and academics, who combined the quality principles of scientific management with new methods of working.[3] In particular, TQM was driven by a belief that the achievement of business excellence involved integrating a series of systems and procedures aimed at preventing and responding to defects in any business process. The adoption and

[3] Joseph Juran and W Edward Demming (American management scholars) provided the theories, which were 're-discovered' by Feigenbaum (1959) who wrote and published 'Total Quality Control'.

application of these new management ideas in Japan revolutionised manufacturing performance and witnessed Japanese companies outstripping their competitors around the globe (Micklethwait and Wooldridge, 1997).

More importantly however, total quality has over time become instituted as a management philosophy which sees barriers (for example, between internal departments or externally between an organisation and its customers) as a reason for poor quality (James, 1996). Whilst TQM has become one of the most durable management innovations, it remains as Grant et al (1994) observe, an ill-defined concept. The Oxford Dictionary of Business defines TQM as:

> "An approach to management that seeks to integrate all the elements of an organisation in order to meet the needs and expectations of its customers." (p. 502)

Research by Ghobadian et al (1998) suggests that in the literature, TQM has been conceived according to:

- underlying values;
- organisation orientation (management style and behaviour, organisational structure and working methods) and;
- tools and techniques.

On the basis of this analysis Ghobadian and Gallaer (1996) developed the following, more detailed definition for TQM:

> "TQM is a structured attempt to re-focus the organisation's behaviour, planning and working practices towards a culture that is employee driven, problem solving, customer oriented, open and fear-free. Furthermore, the organisation's business practices are based on seeking continuous improvement, devolution of decision making, removal of functional barriers, eradication of sources of error, team working and fact-based decision making." (Ghobadian et al, 1998, p. 10)

Key here, is an understanding that quality is determined in the customers 'world', and not only by a set of technically inherent characteristics (Ehrenfield, 1999). With a focus on customers, continuous improvement, establishing the root causes of failures and a broadening of responsibility for quality to include all employees, TQM represents a more radical approach to quality management. In particular, it bypasses some of the more static elements that have characterised quality systems which some authors argue have resulted from the 'standardisation' of quality (Street and Barker, 1995).

Eradicating failures in a system has close synergies with the concern of environmental managers to identify sources of waste and pollution. For example, Spedding et al (1993) suggest that replacing the 'customer' with 'environment' and conceiving quality as environmental quality would enable the principles of TQM to be applicable in an environmental context. The costs of product failure may equally be compared to the costs of waste disposal or a pollution incident. The synergies both in practical terms, and in the potential cost:benefits of identifying waste and pollution as 'failures' in the system, suggest that TQM practices may be employed in order to achieve environmental improvements. This rationale suggests the following proposition:

> 1a. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of Total Quality Management.

3.3.2 'Green Teams'

Teams and team working have been extensively used and developed in organisations since the 1970s (Sims et al, 1993). Teams have been most successfully applied to complex tasks where more work is required than one person can give and which necessitate different roles and skills. Katzenbach and Smith (1993, p. 112) propose a working definition of teams where:

> "A team is a small number of people with complementary skills who are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable."

This notion of mutual accountability is one of the key tenets that distinguishes teams from other forms of 'group working', where in contrast, individual accountability and individual work products are more common (Weiss, 1996). Teams do their 'real work' together, forming purposes and goals that they work towards collectively. The more dynamic and boundary challenging nature of teams, means that they have been valued for their contributions to transformational change in organisations (Weiss, 1996).

Environmental challenges have been broadly identified as being complex and requiring interdisciplinary thought and collective action (Stead and Stead, 1996). James (1996, p. 42) observes that in organisations, environmental change and progress towards environmental goals is frequently hampered by internal departmental boundaries and

latent 'territoriality' which impedes the flow of information. This 'green wall' can prevent the environmental function from being accepted and integrated effectively into the workings of the business (Ayers and Green, 1996; Fineman, 1996a).

The ability of teams to act as change agents and break down existing rigidities in favour of new ways of working makes them an appropriate vehicle for tackling environmental issues in organisations (Moxen and Strachan, 1996). Ayers and Green (1996), note that a team approach has, in a number of studies, proven to be one of the best mechanisms for introducing, informing and involving people in the organisation who are outside the formal, more 'traditional' Environment, Safety and Health (ESH) function. In addition, as teams are valued in particular, for their ability to achieve performance gains beyond limits usually achieved by individuals or groups, they promise a greater likelihood of improvement than isolated ESH departmental initiatives. This suggests the following proposition.

> 1b. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of 'green teams'.

3.3.3 Employee Involvement

In his 1984 work on stakeholder management Freeman noted that the basic element of any framework for organisations must include the central building block of the firm, its people. Schumacher (1973) believed that organisations had a responsibility to provide 'good work' for employees that addressed both their spiritual and creative needs. These inclusive approaches stressed the notion of the organisation as a working community. While in theory, an individual employee should be free to pursue his own interests, it is the nature of being an employee in a modern organisation, particularly at lower staff levels, that you are generally not at liberty to do so (Meima, 1997).

Jones and Welford (1997) argue that progress toward environmental goals requires that organisations rediscover the more 'plural and participative' ways of working, advocated by authors such as Schumacher (1973) and Bader (1945). They further submit that, "respect for the individual is a critical motivator in its own right" (Jones and Welford, 1997, p. 148). These propositions have been partially supported empirically by Klinkers and Neilissen (1996) who showed that involving employees in environmental improvement campaigns through co-decision making (using workshops) was the most

effective way to improve intended corporate environmental behaviour. Their study, while detailed in describing how employees may be involved, did not however provide conclusive proof of actual environmental improvements.

In a more systematic survey of worker involvement in pollution prevention, Florida (1996, p. 92), reported that roughly two thirds of firms in their study involved production workers in prevention efforts. Notably, 64.6% of respondents considered them (production workers) more important than R&D staff (52.2%) and suppliers (49.1%). A further, robust study linking employee involvement to successful environmental improvement measures is reported by Ruiz-Quintanilla et al (1996). Using data from the United States, Toxic Release Inventory (TRI) the authors analysed the results of ten pollution reduction measures in over 10,000 reported cases. They showed that toxic releases were reduced most significantly when they were associated with employee participation strategies, in particular, participative team management, employee recommendations under formal company programmes and internal pollution prevention opportunity audits (Ruiz-Quintanilla et al, 1996, pp. 139-140). Significantly, combining strategies showed incremental improvements in reductions. The authors suggest that these findings need to be supported by case study analysis in order to give a more detailed perspective of what actually constitutes best organisational practice.

This need to pursue detail at an organisational level is supported by findings from Denton (1996) who surveyed a number of leading environmental management proponents in the US. The survey examined a range of issues including opportunities for green marketing, strategic operations and employee involvement in pollution management. Interestingly Denton (1996) noted that 'dual' responses to his questionnaire from an individual organisation revealed markedly differing responses. While the manager cited the use of 'ideas generating contests to reduce pollution', and recognition of employee efforts as important, a respondent at staff level felt that these initiatives either rarely happened or did not exist at all. While research needs to take into account that perceptions may differ, these findings suggest the need for closer examination of actual employee involvement at an organisational level. The preceding discussion suggests the following proposition:

> 1c. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of employee involvement.

In addition to the three characteristics that emerge from Hart's (1995) discussion, an analysis of the literature suggests that two complementary factors may also be usefully considered in the context of continuous improvement. These factors are outlined in more detail below.

3.3.4 Environmental Awareness

The need for employees to be environmentally aware has been written into formal environmental management systems since the development of the first British Standard BS 7750 (Starkey, 1996).[4] Over time organisations have drawn on a number of training approaches to address the challenges of raising environmental awareness. They range from conventional mechanisms such as company newsletters, video presentations, seminars and talks (Klinkers and Nelissen, 1996), to more innovative techniques such as 'eco-dialogue' discussion groups that aim to brainstorm and discuss the issues in order to produce practical solutions (Christie et al 1995). Of significance in these deliberations has been the need to be cognisant of the different *levels* at which environmental concerns may be understood and defined. These organisational and broader contextual levels are illustrated in Figure 3.1.

[4] The standard required that all employees were aware of:

1. the importance of compliance with the standard;
2. the significant environmental effects of their work activities;
3. their roles and responsibilities in achieving compliance with the requirements of the standard;
4. the potential consequences of departure from specified operating procedures (Starkey, 1996).

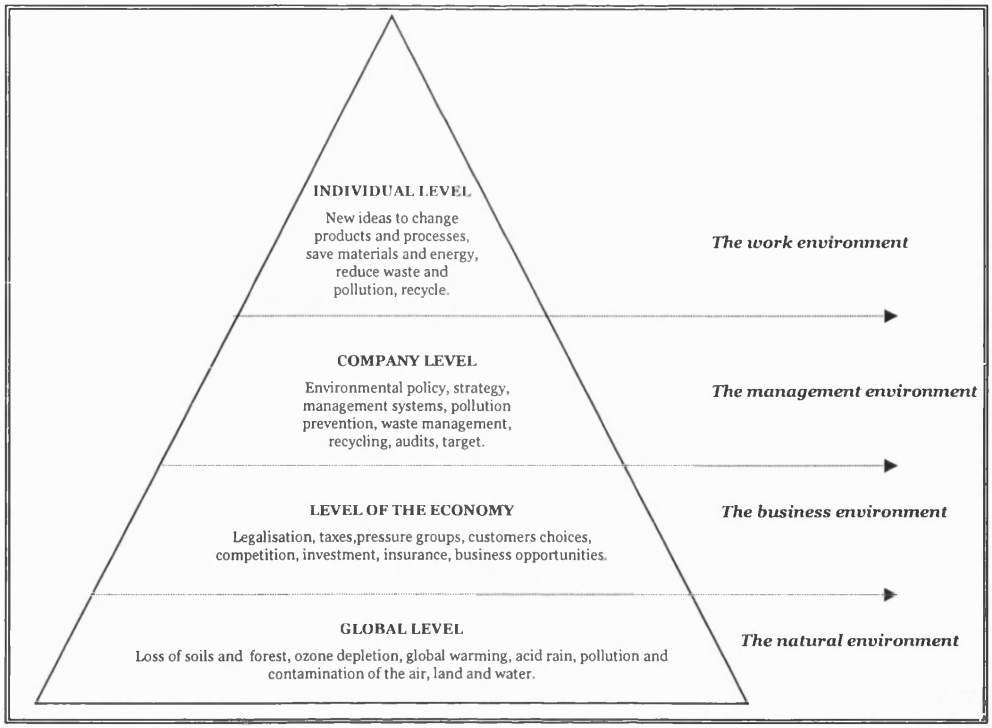

Figure 3.1 Levels of Environmental Awareness (after, Crosbie and Knight, 1995).

It is the inherent complexity in terms of understanding and reconciling global and local concerns that makes effective awareness raising such a challenging issue. Everett et al (1993) demonstrated in their study of executive level employees that even senior level staff who benefit from a strategic overview of the organisation, have difficulty in finding consistency between the levels of understanding required and developing appropriate solutions. Nevertheless, they note in their exploratory study that an increased environmental awareness among interviewees did stimulate actions that saw short-term, profitable but environmentally damaging projects bypassed. Instead firms focused on more long-term projects that were environmentally less damaging but still financially assured.

Awareness is therefore arguably the cornerstone of any environmental management programme, as employees need to understand both the issues and the actions being taken by the organisation. As Halme (1996) observes, growing environmental awareness improves staff willingness to approve of new criteria, even when it will result in additional work for those concerned. A raised understanding also helps staff members to recognise where improvements can be made (Wolters et al, 1995), and reduces the

likelihood of mistakes. As North and Daig (1996) note, it only takes one ill-informed employee to make an error that leads for example, to an unconsented discharge and consequent regulatory penalties. This research to date supports the notion that environmentally aware employees are more likely to take pride in performing their job in an environmentally responsible manner, and this is work which would benefit from further investigation (Christie et al, 1995)

The importance of environmental awareness both as a precursor for more detailed targeted training and in stimulating actions that improve environmental performance suggests the following proposition:

> 1d. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of employee environmental awareness.

3.3.5 Environmental Values

Organisational culture has been described as being composed of beliefs, values, attitudes and norms (Sims et al, 1993). Culture influences how employees behave and function within an organisation. Successful companies, it has been argued have strong cultures where values unite members (Peters and Waterman, 1982). Significantly though, maverick cultures where value conflicts exist, have also been shown to foster creativity and success, as at Microsoft (Weiss, 1996). Values are clearly a major component of organisational culture and while a culture may embody a particular set of values it is important to recognise that organisations do not really posses values apart from the values of their members. As such values have been described as:

> "The most distinctive property and defining characteristic of a social institution." (Rokeach, 1979, p. 51)

Values are at the core of a person's character and reflect both early learning and progressive socialisation (Weiss, 1996). This means that values tend to be relatively stable and do not change as readily as attitudes or beliefs. Consequently values are believed to have a substantive influence on the affective and behavioural response of individuals (Meglino and Ravlin, 1998).

Authors working in the environmental field argue that the social climate, which influences and fashions the values of individuals, has progressively changed to embrace

environmental concerns. As a result, once stable values have shifted to encompass a more inclusive perspective of the natural environment and its relationship with business (Welford, 1997). As individual values evolve to encompass environmental concerns authors argue that they may increasingly find themselves out of kilter with the prevailing culture of the organisation in which they work. This is particularly significant as it impacts both job satisfaction and the performance of the individual. Hoffman (1993) argues that, organisations that fail to keep abreast of these societal changes in terms of adjusting their approach to environmental management, will increasingly witness sub-optimal performance from their workforce. Achieving more effective environmental management, it is suggested, will therefore demand a gradual realignment of organisational culture (Halme, 1997).

By removing areas of mismatch between individual and organisational values, organisations are more likely to achieve improved performance. This shared or congruent value position is argued by authors to be particularly valuable in an environmental context where the connections between actions and improved environmentally sustainable performance may not be so transparent or immediate (Dodge, 1995, 1997). The need for supporting congruent environmental values suggests the following proposition:

> 1e. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of environmental values.

3.4 Identifying Resource Characteristics: Clean Technology

I have argued that in relation to the chosen context, research would be most valuably directed towards examining the resource characteristics of the pollution prevention and clean technology capabilities in Hart's (1995, 1997) framework. The addition of clean technology to the author's 'sustainability portfolio' is a development that acknowledges the role that new technologies will need to play in the future. Clean technologies are distinct in that they encompass input reductions or substitutions to a process, rather than 'add-ons' or 'end-of-pipe' solutions. Integrated changes mean that they aim to prevent pollution from the outset, often through recycling techniques which ultimately result in cleaner consumer products (Kemp, 1993).

I have also illustrated in discussions of the resource-based approach that capability development is viewed as being interconnected and path-dependent (Barney, 1991; Hart, 1995). This suggests that underlying resources and their characteristics have a supporting role that extends beyond the key capability that they are most closely associated with. Although it is not the intention of this analysis to address product stewardship directly, for the purpose of a more rounded analysis the two resource characteristics associated with product stewardship (cross-functional working and Life-Cycle Assessment) will also be discussed in the context of clean technology. This rationale is supported by a recognition that, these capabilities share the key quality of social complexity and as I show below their resource characteristics are conceptually linked.

A capability in clean technology is viewed as being supported by the vital resource of technological innovation. I have suggested that for the purposes of this analysis this resource is characterised by the elements, cross-functional working, Design For the Environment, Life-Cycle Assessment and, partnerships and collaboration. These characteristics are considered in turn below.

3.4.1 Cross-Functional Working

Cross-functional working describes a situation where a dedicated team is comprised of members who represent a variety of organisational functions (Trott, 1998). For example, in the context of environmental technology development a team may consist of members from product management, design, engineering and manufacturing, environment, marketing, sales and the legal department. This collection of expertise from across the organisation is frequently seen as an opportunity to generate 'creative conflict'. The result, it is argued, is a greater awareness of problems which enhances the search for solutions and in doing so motivates employees to adapt and change their approach accordingly (Weiss, 1996).

Cross-functional teams have been most notably applied in the context of new product development (NPD). This is based on the rationale that NPD is by its nature a,

> ".. cross-disciplinary process and suffers if it is segregated by function." (Trott, 1998, p. 153)

However, as companies are frequently organised on the basis of function, cross-functional teams may run counter to existing hierarchies. This can make teamwork of this type difficult to operate and maintain, especially if functional working is ingrained in the organisation's heritage. To combat this situation some organisations, such as ICI, which rely heavily on the creativity of their research and development activities have adopted matrix structures[5] which allow work across the functions facilitated by dual lines of communication.

This need to adopt new working practices and organisational structures has been identified by Winn and Roome (1993) in their analysis of research and development (R&D) activity in the context of environmental challenges. Their research suggested that without a more thorough integration of environmental knowledge throughout the development process, key issues are neglected and become isolated, frequently at board level. In order to integrate environmental criteria more effectively into R&D, organisations need to develop structures that facilitate learning (Roome, 1994). Cross-functional teams and networks that draw explicitly on environmental expertise and that are linked to the formulation of business strategy, are seen as being crucial in this context (Groenwegen and Vergragt, 1991). The success of this approach has been illustrated by Shrivastava (1995) is his analysis of environmental technology development at 3M, where environmental criteria inform each stage of a product or process life-cycle.

The systemic and complex nature of environmental challenges points to a need for new approaches in technology development. This new thinking needs to be supported by appropriate organisational structures, that promote integrated working. These arguments suggest the following proposition:

> 2a. A firm will be more likely to develop a clean technology capability when it can demonstrate the resource characteristic of cross-functional working.

[5] A matrix structure is defined as any organisation that employs a multiple command system including not only a multiple command structure but also related support mechanism and associated organisational culture and behaviour patterns (Ford and Randolph, 1992).

3.4.2 Design for the Environment & Life Cycle Assessment

The concepts of Life Cycle Assessment (LCA) and Design For The Environment (DFE) are considered in tandem because their founding concepts, principles and aims are inextricably linked. DFE and LCA have emerged as key components of the developing, 'industrial ecology', school of thought. Industrial ecology embraces a systems perspective by drawing an analogy with natural ecological systems (Richards et al, 1994). Just as natural systems operate through a web of connections where organisms feed off each other as well as the waste products generated through activity within the ecosystem, so too it is argued, do industrial processes and units. Viewing processes as interconnected in this way allows energy, materials and waste flows to be systematically assessed for opportunities to reduce, reuse or recycle.

Operationalising these concepts it is argued can be most effectively achieved through a DFE approach, which according to Allenby (1994, p. 139) is,

> "... about ensuring that all relevant and ascertainable environmental considerations and constraints are integrated into a firm's product realisation (design) process. The goal is to achieve environmentally preferable manufacturing processes and products, while maintaining desirable product price/performance characteristics."

By building on established design criteria[6] DFE is seen as a pragmatic mechanism for companies to use when working towards the integration of environmental criteria. In practice DFE can embrace two categories of activity. Projects may either be global and comprehensive extending to all areas and design functions, or more specific, individual evaluations of products, processes and inputs (Allenby, 1994). As implementing a full DFE would be a complex, multidimensional undertaking most projects to date have focused on specific design issues. These projects may be broken down into three phases:

1) scoping, which determines the depth of the analysis;
2) data gathering, frequently employing LCA techniques and;
3) data translation where the information obtained is turned into 'tools' that designers and engineers can use (Allenby, 1994).

[6] DFE draws on the 'Design for X' concept (Gatenby and Foo, 1990) where 'X' is a desirable product characteristic such as manufacturability or safety.

An example of a targeted project is provided by Shrivastava (1995), in his analysis of Riker, 3M's pharmaceutical unit. By substituting a solvent solution coating for medicine tablets with a water-based coating, the unit was able to save $180,000 in pollution control equipment and $15,000 per year in materials cost; a step which cost the firm $60,000 (Shrivastava, 1995, p. 135). Minimising the use of hazardous chemicals also prevented 24 tons of air pollution a year.

The use of a DFE approach is also viewed as a critical factor in the ability of firms to address the demands of increasingly sophisticated customers who are looking for products that reduce their potential environmental costs (Allenby, 1994). The facility to recycle products at their 'end of life', as introduced by BMW in their 'design for disassembly' (a specific application of DFE) shows how benefits may be extended along the supply chain (Stead and Stead, 1996). This is a key, if complex, area of future clean technology development.

LCA, as indicated above, is an important component of DFE because it generates data on environmental impacts. In essence, LCA is an information gathering exercise, with its strength lying in the systematic nature of data collection. Although LCA theoretically incorporates four phases (goal definition, inventory analysis, impact assessment and improvement) most LCA projects focus on, and make use of, the definition and inventory stages.[7] These stages define the purpose and boundaries of the LCA and aim to provide a detailed picture of the raw material and energy inputs used by a system, and of the solid, liquid and gaseous wastes produced as outputs.

Knowledge obtained through LCA techniques allows firms to consider more carefully the costs and environmental burdens associated with a particular product and, therefore, make more accurate comparisons with alternatives or potential substitutes (SustainAbility et al, 1993). For example, AT&T used LCA techniques to assess the feasibility of producing a 'green telephone', and in doing so developed a series of environmentally desirable attributes against which materials and components could be assessed. One illustrative finding was that by investing in and developing new conductive adhesives the company could eliminate the need for lead connections

[7] This relates both to the complexity and relatively rudimentary state of LCA methodologies, which remain under development (Richards et al, 1994).

(Sekutowski, 1994). Without the detailed assessment provided by the LCA approach the opportunities and entry points for this new technological innovation would not have been realised.

These examples suggest that the foundations for cleaner technologies are established through employing the concepts and practices inherent in DFE and supporting LCA methodologies. This rationale suggests the following proposition:

> 2b. A firm will be more likely to develop a clean technology capability when it can demonstrate the resource characteristics of Design For the Environment and Life-Cycle Assessment.

3.4.3 Partnerships and Collaboration

Collaborating or partnering with other firms was traditionally viewed by businesses as 'second best' to the strategic option of going it alone (Contractor and Lorange, 1988), and as such was generally reluctantly undertaken when all other options were exhausted. However, the 1980s and the 1990s saw a change of perspective, with an increasing number of firms pursuing partnerships that involve joint activities along the value chain in production, sourcing and R&D.[8] In the United States, more than 20,000 alliances were formed between 1987 and 1992 compared with 750 during the 1970s (Micklethwaite and Wooldridge, 1997). The attraction of alliances has grown through the potential for firms to realise what Kanter (1994), terms 'collaborative advantage'. By working together, companies derive a range of benefits including, improved access to capital and business, greater technical critical mass, shared risk and liability, technology transfer benefits, reduced R&D costs and access to marketing and distribution skills (Trott, 1998). While alliances have largely been viewed in financial terms, Kanter (1994) argues that it is the human relationships that ultimately determine the success of an alliance. She likens the life-cycle of a strategic alliance to that of a personal relationship between two individuals involving stages of courtship, engagement and change.

[8] While the terminology in this area has a tendency to overlap the generic term for collaborative working is generally accepted as 'strategic alliance', which is an agreement between one or more partners to share knowledge and resources, which could be beneficial to all parties involved (Vyas et al, 1995). Faulkner (1995) suggests that there are three generic types of alliance: joint ventures (usually a separate entity where the partners are equity holders); collaborations or non-joint ventures (which without a legal entity are more flexible); and consortia (where a number of partners come together).

One subset but key area in the development of alliances, has been the co-operation between firms in relation to technological innovation and R&D. Again, authors have characteristically taken an economic perspective in focusing on the benefits of R&D collaboration as relating to, risk reduction, shared costs, market access and competitive positioning (Hagedoorn and Schakenraad, 1990). However, research in this context has also adopted more sociological perspectives (Callon, 1992). These latter studies have considered the success of inter-firm relationships both in terms of the individual actors involved and in relation to the networks that become established within and between firms and their broader stakeholder environment (Coombs et al, 1996). Emerging from this literature has been a recognition that while external conditions are important in influencing relationships, the way firms choose to approach collaborative working is largely influenced by internal organisational factors relating to culture, structure and policy (Kanter, 1994; Green et al, 1994).

These insights are helpful when considering how firms approach the development of clean technology. While partnerships as a business strategy have clearly grown in favour and frequency in a general business and technology context, the potential value of using this strategy for environmental developments has been less thoroughly explored. This relates to the fragmented nature of firms' engagement with environmental issues and as a consequence their relative abilities to seek added value through partnerships. As DeSimone and Popoff (1997) note, many firms have yet to reach a point of constructive dialogue with the expanded range of stakeholders that have emerged through environmental concerns. [9] As a result the potential for relationships with new partners remain unexplored.

This is significant as the stimulus and insights for clean technology frequently come from interactions that extend beyond the most immediate and apparent relationships with customers and suppliers. Clearly relationships in the marketplace are important, as Green et al (1994) illustrate in their survey, where a range of firms indicated that collaboration with suppliers and customers rated most highly in the development of product and process innovations. However evidence suggests that partnering in the

[9] DeSimone and Popoff (1997, pp. 135-136) suggest that the history of industry response to environmental concerns has four main stages: denial (when companies typically were secretive about their affairs); data (the production of facts to refute charges of mismanagement); delivery (the emergence of reports of environmental performance) and dialogue (the establishment of a continuous relationship with stakeholders).

workplace, with research organisations, in the community and in the realm of public policy can also be a source of more eco-efficient technology as it helps companies to 'reappraise' conventional approaches to problems (Peattie, 1995).

For example, EBARA, a Japanese environmental engineering company, became involved with Tokyo University's Zero Emission Initiative in their goal to minimise company and customer emissions. Through embracing the concept of zero emissions the company was incentivised to develop a new treatment for flue gases. The result was the Electron Beam Flue Gas Treatment System, which removes harmful pollutants and in doing so generates ammonium nitrate and ammonium sulphate, as by-products. These are key components for agricultural fertiliser. The resulting technology therefore has significant implications for rapidly developing economies such as China where both energy and food demands are increasing (DeSimone and Popoff, 1997).

At 3M, the global industrial and consumer products company, extensive consultation and development with consumers resulted in the production of Dryview a laser imaging system. Dryview replaces the wet processing, hazardous chemical use and disposal that accompanies the development of film images for medical CAT scans, with a new film that develops through the precise application of heat. This new technology brings cost reductions of up to 20% and capital savings approaching 50%, as well as eliminating the need to use and dispose of water (DeSimone and Popoff, 1997). By seeking out and integrating user knowledge, the company was able to realise substantial cost saving for the consumer and bring forward a more durable and sustainable technology.

These examples suggest that the sources and opportunities for environmentally beneficial innovation may be found through developing partnerships in the marketplace and with broader research and interest groups. This contention points to the following proposition:

> 2c. A firm will be more likely to develop a clean technology capability, when it can demonstrate the resource characteristics of partnership and collaboration.

3.5 Resource Development: The Influence of Moderators

The preceding discussion has adapted the concepts and frameworks of Barney (1991) and Hart (1995, 1997), in order to empirically investigate the resource characteristics that it is proposed may contribute to the development of potentially valuable environmental capabilities. On the basis of the chosen research context, the discussion has focused on the capabilities of pollution prevention and clean technology. By adopting an approach founded on resource-based logic I am implicitly interested in the links between internal firm characteristics and performance. However, as environmental capability is a new and relatively under-researched area I am also interested in factors that may affect the links between these variables. While writers have pointed to the ambiguous and tacit nature of resources (Rumelt, 1984; Clarke and Pitt, 1996) they say less about how resource development may be impacted either positively or detrimentally by the presence of other factors internal to the firm, which are not classed as resources. Therefore to understand how resource characteristics contribute to capability development, there is a need to take into account factors that may impinge on this relationship.

The notion that additional factors internal to the firm may impact the strategy-performance relationship is not new as it goes to the heart of contingency theory. Contingency views, which are based on systems concepts, see the organisation as a series of subsystems delineated by identifiable boundaries from its environment (Kast and Rosenzweig, 1985). It is assumed that maximising the congruence between the organisation and its environment through organisational design will lead to greater efficiencies. In order to do this, contingency perspectives look towards understanding the interrelationships among subsystems. In particular, it is considered important to examine the *constellations* of characteristics on which relationships are *contingent.* This notion of contingency, that is, that the form and strength of a proposed relationship may be impacted by additional factors, is partially alluded to in the extant literature on environmental capability (see Table 2.5).

Several authors give consideration to the moderating influence of external business factors. Russo and Fouts (1997) in particular, pay detailed attention to the potential of industry context and specifically industry growth, to affect the development of resources. They argue that where industry growth is high, improvements in

environmental performance will positively impact firm profitability. Hastings (1999) in her South American study, also considers how what she terms 'modern socio-political pressures' have moderated the elements of new strategic capability. She argues that where the impacts of global publicity are felt most keenly, 'beyond compliance' environmental management practices are more widespread. Similarly, in areas where indigenous populations are collectively organised, company use of participatory development and community assistant programmes are greater (Hastings, 1999). These limited examples suggest that the moderation of capability development needs to be more thoroughly explored.

Significantly, even though most studies of capability analysis are focused at organisational level, few authors extend their analysis to take into account the potential moderating influence of firm level variables. However, the importance of addressing organisation-level factors is illustrated by Sanchez (1997). He shows how four key factors (the centralisation of environmental information, firm size, the intensity and integration of R&D, and the perception of regulation as opportunity) influence the relationship between environmental regulation and innovation at firm level. From the extant environmental capabilities literature reviewed in chapter two, it is possible to distinguish a number of internal issues to which authors have made passing reference.

Marcus and McEvily (1999) draw attention to the influence of a firm's ongoing competitive strategy, firm size, and past experience with innovation. Hastings (1999) cites the importance of company track record and its associated reputation and Sharma and Vrendenberg (1997) acknowledge that other (non-environmental) organisational strategies may well have an influence on the development of environmentally valuable capabilities. The following sections therefore consider three of these identified factors that could play a role in moderating the capabilities considered in this research project.

3.5.1 Non-environmental organisational strategies

It is the nature of a significant percentage of current environmental management writing that the strategic importance of environmental concerns is considered equivalent to more 'traditional' business issues (Newton and Harte, 1997). In fact, a number of authors present environmental, and in particular sustainable development issues, as *the* strategic issue facing organisations in the twenty first century (Shrivasatava, 1994; Stead and Stead, 1996; Welford, 1997). As a result there has been a

growing call for organisations to integrate environmental concerns into all areas of their business (Crosbie and Knight, 1995).

While the debate as to whether this is a desirable aim is far from exhausted, the reality of implementing strategic environmental initiatives in organisations is that they frequently jostle alongside other initiatives for both human and capital resources. As Fineman (1996b) illustrates in his study of the environmental practices of six UK supermarkets, where financial positions are precarious, or where competition for survival is fierce, environmental initiatives rarely go beyond the minimum required for compliance. This suggests that in situations where little organisational slack exists, internal contemporaneous strategic initiatives frequently have the ability to outcompete environmental projects for key resources.

The impacts of this internal competition will vary according to the nature of the initiatives. For example, the results of strict cost cutting measures can see a reduction in the availability of management time and expertise. In today's downsized organisations, reallocating managers and team members to short term profit focused projects can reduce the knowledge capacity and effectiveness of more long lived teams that are characteristic of environmental work. Conversely, a drive for product quality is likely to see investments in skills and hardware that have synergies with environmental projects, as discussed in section 3.3.1. The capacity built through total quality practices can positively influence implementation of environmental practices. Therefore as Sharma and Vrendenberg (1997) suggest, it is important to consider how other organisational strategies can influence the development of environmental capability. This discussion leads to the following proposition:

> 3a. The development of pollution prevention and clean technology capabilities will be moderated by non-environmental organisational strategies.

3.5.2 Track record on environmental issues

Traditional strategy researchers have often cited the unique historical circumstances of a firm's establishment and ongoing development as important in determining a firm's long term performance (Stinchcombe, 1965). This view has been rekindled by resource-based perspectives which pay explicit attention to understanding the role of unique histories. This contrasts with the popular environmental models of the firm that have

argued for an understanding of firm performance independent of either historical or other idiosyncratic attributes of the firm (Porter, 1980).

However, the importance of history is an integral part of Penrose's argument. As Eccles and Nohria (1992, p. 60) observe:

> "Good strategy is never ahistorical – it is always path dependent. At any moment in time the viable strategic options open to a manager are influenced by commitments, choices and conversations that have already occurred."

Importantly, learning tends to be local, and as such the opportunities to develop will be 'close to' previous activities (Teece et al, 1997). This is frequently the case as past experience conditions the alternatives that management are able to perceive.

These arguments suggest that the way any issue or resource is handled and developed in the organisation will depend on a combination of current knowledge and past experiences. In her study of oil companies in South America, Hastings (1999) noted how following economic liberalisation the influx of foreign operators generated considerable environmental damage (through issues such as road building and pipe-line construction) as well as significant cultural displacement and disturbance. Arguably, this occurred as a result of companies pursuing a 'business as usual scenario' and not taking into account changes in the social and political climate. Their cumulative track record did not allow for more sensitive working and subsequently directed the methods they used to exploit oil fields. Only when the companies started to address emerging, current concerns more closely did they break with tradition in order to develop new practices and expand existing niche activities.

Similarly, Marcus and McEvily (1999) showed how contrasting approaches to the use of hazardous materials contributed to shaping the environmental competence of their two case study firms. In one firm, a long term commitment to reduce to use of cyanide in production led, following a process of experimentation, to the development of a new manufacturing line that totally removed the need to use cyanide in the process. In comparison the smaller case study firm, which had chosen to avoid environmental regulatory obligation where possible, continued to use cyanide making token reductions to avoid emissions charging. As a result hazardous chemicals remain a part of the

production process, requiring recovery and specialised disposal. In this paired example experiences built up over time have dictated significant influence over how environmentally beneficial practices and processes are developed. These arguments point to the following proposition:

> 3b. The development of a pollution prevention capability will be moderated by a firm's track record on environmental issues.

3.5.3 Experience with innovation

Innovation has been diversely conceptualised and is often confused with invention. As Abbey (1982) argues the concepts are qualitatively different. Invention involves an 'act of insight' which goes beyond the normal exercise of technical or professional skill resulting in the emergence of 'new things'. Innovation however does not involve this origination or 'act of insight', rather, it is the development of a new process or way of doing things. In a logical sequence invention proceeds innovation but, it is not a prerequisite for innovation as an innovatory product or process can be developed separately from an invention in both time and location (Myers and Marquis, 1969). Although the term innovation has been freely applied, it is most frequently related to conceptions of technological change in an industrial setting (Belcher et al, 1996; Loveridge and Pitt, 1990). In this context Freeman (1974) describes innovation as the technical, design, manufacturing, management and commercial activities involved in the marketing of a new (or improved) product or the use of a new (or improved) manufacturing process or equipment. Therefore rather than representing a neat, bounded concept the components of innovation make for a multifaceted, multidimensional process. In particular innovation is about applying solutions to progressively defined problems.

The processes and diffusion of innovation have been well studied (see for example, Dosi, 1984; Rothwell, 1992). Regularities in technological change suggested to researchers that advances took place in certain directions and that they were not fine-tuned to changing demand and cost conditions. As Kemp (1993) notes, this phenomenon has been related to technological opportunity, organisational capability and search heuristics that are typical in the scientific community. Important to these discussions are the concepts introduced by Nelson and Winter (1982) and developed by Dosi (1984), of technological paradigms and the processes of technological change as

described by technological trajectories. Technological paradigms, embody the skills and knowledge that accompany the stages of a firm's development and are usually exemplified by an artifact, for example an integrated circuit or an automobile. In building these skills the progression of the firm may be described by a trajectory which is characteristic to that firm. This trajectory also reflects the dynamics of the selection environment, what is happening in the world outside the firm. A particular technology may therefore be characterised by a suite of skills and technical abilities developed to complete the task most efficiently. However, existing trajectories with their concomitant structures are not necessarily appropriate for new technologies.

New technologies frequently require institutional changes. In their analysis of environmental R&D theory and practice, Winn and Roome (1993) observe that environmental concerns have not been translated well in an innovatory context. This is partly due to unconventional decision-making routes[10] and in particular the result of inadequate organisational design, training and competence in environmental research. This view is supported by Kemp (1993) who also observes that training and production routines have to date typically been geared towards older technologies and their more linear approaches which are not appropriate for environmental innovations that require a more dynamic outlook.

In a survey of the move toward more environmentally conscious manufacturing Florida (1996), identified that new production technologies and processes associated with lean production and agile manufacturing significantly improved productivity and performance. In addition, the analysis also showed that these new ways of working played an important role in creating openings for the introduction of cleaner production technologies. These findings reinforced an earlier empirically based proposition by Maxwell et al (1993) that there is a positive relationship between lean production and innovative environmental practices.

That more innovative manufacturing and production technologies support moves towards environmentally proficient technologies suggest that the adoption and

10 Environmental discussions tend to occur at board level rather than between the business units and the R&D department (Winn and Roome, 1993).

development of clean technologies is influenced by past experiences of innovation. These arguments suggest the following proposition:

> 3c. The development of a clean technology capability will be moderated by a firm's experience with innovation.[11]

3.6 Incorporating Organisational Context

I have argued that in order to ascertain whether hypothesised environmental capabilities are under development, it is necessary to empirically investigate the resource characteristics that underlie these capabilities. I have also suggested that this relationship between resources and capabilities has the potential to be moderated by several key factors internal to the firm. By introducing the concept of moderators I have implied that capability development may not necessarily be solely explained by economically rational perspectives. Rather, there may be contextual factors that relate to a firm's traditions, prevailing culture and its relationship with external constituents that interact to influence capability development.

In chapter two I indicated that employing institutional perspectives alongside resource-base thinking may enhance our understanding of capability development. Oliver (1991, 1997) draws these perspectives onto firmer foundations by developing a process model of firm heterogeneity that combines insights from both resource-based and institutional theoretical perspectives.[12] Oliver (1997) argues that the processes and outcomes of resource selection are governed by the interaction between resource-based and institutional determinants. She considers these factors at three levels, the individual, the firm and inter-firm. While the model is concerned with links between the levels as well as their individual analysis, of particular relevance to this discussion are Oliver's (1997) deliberations at a firm level. Specifically, the author argues that,

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[11] Innovation is considered for the purposes of this proposition to be a *management process* which Trott (1998, p. 12) outlines as being, "... the management of all activities involved in the process of idea generation, technology development, manufacturing and marketing of a new (or improved) product or manufacturing process or equipment."

[12] Institutional theory is interested in the processes by which items become institutionalised and the role of institutions in society. Oliver (1991) describes the institutional environments of organisations as including, regulatory structures, government agencies, laws, courts, professions, interest groups and public opinion.

> " ... the social context of resource decisions also affects the likelihood of optimal resource use and procurement." (Oliver, 1997, p. 704)

Oliver (1997) suggests that low levels of political and cultural support for resource choices can act as 'institutional isolating mechanism'.[13]. In this situation the economic rationale for acquiring a new resource may be proven but the potential for conflict with existing practices or work cultures may prevent an optimal choice. These isolating mechanisms can also originate externally if key constituent groups, such as regulators or local interest groups, threaten to withdraw support for firm activity on the basis of a controversial resource acquisition. For example, the installation of a new treatment facility that reduces harmful waste but generates side effects such as increased emissions and additional traffic movements. A less optimal but more socially legitimate choice may result. Oliver (1997) argues that one way to overcome this sub-optimal decision making is for managers and teams to increase and mobilise support for resource choices that fall outside accepted norms.

Oliver (1997) puts a strong case for the consideration of contextual factors, suggesting that it may be useful to conceive of firms as possessing both 'resource capital' and 'institutional capital'.

> "Resource capital can be defined as the value-enhancing assets and competencies of the firm. Institutional capital can be defined as the firm's capability to support value-enhancing assets and competencies. Institutional capital is the *context surrounding resources* and resource strategies that enhances or inhibits the optimal use of valued resource capital." (Oliver, 1997, p. 709, emphasis added)

Several authors now argue that organisational context as conceived here by Oliver (1997), has been neglected when considering the development of environmentally valuable resources and capabilities. Moxen and Strachan (1998) maintain that existing structures and cultures frequently challenge the resource acquisition and development required for the successful application of environmental initiatives. Similarly, in an empirical study in the US automobile industry, Rothenberg et al (1993) observed how established organisational structures and practices exerted a 'braking' effect on the development of strategic environmental programmes. The need to mobilise support for

[13] In this context isolating mechanisms, are distinct from their resource-based conception. Here they refer to internal barriers that result from a reluctance to acquire or imitate resources that do not 'fit' with a firm's political and cultural context.

resource choices has also been identified by Sharma et al (1999) who show that when top managers legitimise environmental issues by raising their importance above mere regulatory compliance, resource and capability development is expedited in the firm.

In her study of two Finnish paper facilities Halme (1996) illustrates how the institutional context of the firms, which she terms their 'environmental management paradigm', changed in response to both internal and external pressures. The result of this realignment was the development of institutional capital that supported the development and acquisition of environmentally valuable resources. Hasting's (1999) study of the oil industry also showed that those firms which developed new 'operational paradigms' that embraced environmental concerns were better equipped to work sensitively in environmentally fragile regions. The development of this capital also served to protect their rights to operate in these regions in the future. Selected key contextual elements identified by Halme (1996) and Hastings (1999), which are considered key to this analysis, are summarised in Figure 3.2.

Environmental Management and Operational Paradigm: Selected Dimensions		**Summarised Dimensions**
Halme (1996)	Hastings (1999)	
• concept of the product (e.g. as part of a product life-cycle)	• concept of operational activity (e.g. offshore strategy)	*concept of operational activity*
• relationship between the product and the environment (e.g. awareness of problems of packaging waste)	• relationship between operation and the environment (e.g. minimise loss of biodiversity)	
• parties responsible for the environment (e.g. partnership approach to environmental concerns)	• relationship with local stakeholders (e.g. stakeholder involvement)	*relationship with stakeholders*

Figure 3.2: Selected Dimensions of Institutional Context

These illustrations and the arguments presented above support the proposition that firms need to cultivate 'environmental institutional capital' to support the development of, as Oliver (1997) suggests (environmentally) valuable capabilities. The next two sections expand on the key areas which, are summarised in Figure 3.2, as being important components of environmental institutional capital. They are, the

organisation's concept of its operational activities and the way in which the organisation perceives and manages its relationship with stakeholders.

3.6.1 Concept of Operational Activity

The way in which companies conceive their business and operations is fundamental to how they undertake production and marketing activities in the long term. Authors, in particular those working from the perspective of organisational change and learning, have identified that the key actors or decision makers in an organisation develop 'mental models' based on a complex interaction of factors that include external changes and cultural conditioning (Senge, 1990; Weiss, 1996). These mental models encompass beliefs and assumptions generating a shared vision that colours the way issues are perceived. As DeGeus (1997) explains, these models are fundamental to the way decisions are driven in organisations and therefore the ability to unfreeze these frames of reference to changing circumstances is an important part of staying competitive. The success of the Anglo-Dutch Shell oil company over the years, is attributed in part to its ability to challenge the mental models of its managers (Pugh and Hickson, 1996). For natural resource and extractive companies, developing this ability is particularly important, as the context of their day-to-day activities has changed considerably over the last decade. The choice between encouraging or eschewing environmentally valuable resources is driven increasingly by the way managers perceive their own and, by definition, the company's role in the context of this relationship.

This is well illustrated by Halme's (1996) analysis of how the paper producer UPM-Kajaani conducted its activities in Scandinavia. For many years sustainable forestry in this company was achieved by maintaining the volume of timber in the forests. Intensive forest management, which included the practice of mono-cultures and clear cutting, was considered the most efficient method of growth and harvesting. Maintaining a competitive position in the marketplace depended on the quality and price of the product as well as reducing emission levels and chlorine usage in the face of consumer pressures. However a combination of pressures from, in particular (in this study) an internal change agent led to a re-evaluation of this relationship (Halme, 1996).

At UPM managers began to re-evaluate their beliefs, realising that sustainable forestry would require improving biodiversity, which in turn demanded that they acquire more

detailed information about forest ecosystems. By learning about the natural processes of forest growth, it was identified that growing a diversity of species resulted in better wood quality. Therefore the most efficient method of planting and harvesting involved multi-species growth and more selective felling that allowed natural forest ecosystems to survive. As a consequence, remaining competitive on price and quality increasingly called for developing a working culture and concomitant practices that supported biodiversity based forestry.

Re-appraising what it means to be an electricity producer has also altered the way that Ontario Hydro, one of Canada's largest electrical utilities, does business (DeSimone and Popoff, 1997). Rather than accept as a given increased energy demand, and associated demand-led increases in the use of non-renewable fuels, the company has sought to change previous frames of reference and become a leader in energy efficiency and environmental technologies. By looking beyond current technology, through a renewable energy technology programme, the company is seeking to promote the development, and marketplace acceptance of solar, wind, landfill gas and other renewable energy sources (DeSimmone and Popoff, 1997). Arguably, the impetus for investing in, what will be environmentally valuable capabilities in the long-term, comes from asking new questions and challenging old assumptions about how the organisation conducts its business. The preceding analysis and these illustrative examples suggest the following proposition:

> 4a. A firm is more likely to develop the capacity associated with environmental institutional capital when it can demonstrate a proactive relationship between its operational activities and the natural environment.

3.6.2 Relationships with Stakeholders

The need for an organisation to manage relationships with groups and individuals both internal to and external to the firm has been the subject of extensive research in management and the social sciences. The analysis of stakeholders and the practice of stakeholder management became well established through the writings of Mitroff (1983) and in particular Freeman (1984). Their work reflected a changing business environment characterised by increasingly complex social systems comprising an expanded network of stakeholders. Rather than focusing purely on primary

stakeholders[14], authors suggested that firms begin to take greater account of secondary stakeholders, who although not essential for firm survival from a traditional perspective, could also be considered capable of exerting significant influence on firm activity (e.g. pressure groups, non-governmental organisations) (Clarkson, 1995). Therefore rather than focusing on groups and individuals with a 'stake' in the organisation (Caroll, 1993), Freeman (1984) broadened the definition of a stakeholder to encompass anyone who could 'affect or be affected by' firm activity.

Although it has been argued that the stakeholder concept as theory remains unclear (Donaldson and Preston, 1995) the inclusive nature of stakeholder perspectives has made it both useful and increasingly popular as a framework for examining how organisations respond to environmental issues. While some authors have suggested that stakeholder concepts allow us to engage in fundamental questions about whether non-human entities (such as forests, air or water) should be accorded stakeholder status (Starik, 1994), others have harnessed stakeholder perspectives as a way of understanding and analysing business-environment relationships (Fineman, 1996b).

In his study Fineman (1996b) identifies how four industry sectors, supermarkets, automotive, power and chemicals have interpreted and dealt with 'greening' pressures from a series of stakeholders. As suggested above, Fineman (1996b) identifies that the perspectives of managers play a key role in determining relationships with stakeholder groups. Significantly, where managers strive to develop constructive relationships with stakeholders, the organisation is better able to address associated pressures. In this study the author also noted that pervading antagonistic relationships meant policy and practice in the organisations studied remained substantially unchanged. However, the risks associated with marginalising stakeholder groups are illustrated by the well-documented case of the Brent Spar and Shell's relationship with Greenpeace, the environmental campaigning organisation.

Although Shell's option to dump the redundant oilrig at sea was argued scientifically to be the most environmentally benign option, pressure from Greenpeace, which included the mobilisation of a consumer boycott, forced an embarrassing climb down for the oil

[14] Those essential for firm survival are usually considered to be shareholders, suppliers, customers and employees in traditional texts.

company. Following this episode Shell radically changed its approach and publicly committed to engaging in dialogue with Greenpeace and in doing so put its relationship with environmental pressure groups on a new footing. The learning process arguably strengthened Shell's ability to both deal with controversial relationships and importantly to develop an institutional context that viewed environmental concerns equally (Neal, 1997).

While the precipitation of 'dialogue through crisis' resonates throughout the environmental literature, examples of constructive relationships from the outset are also evident. Prager (1997) reports how a potentially controversial mining operation on Vancouver Island in Canada exhibited an excellent environmental track record as a result of (in the author's analysis) extensive co-operation with the local community and associated constituents for the entire life-cycle of the mine from inception to closure.

These analyses suggest that where companies are proactive, that is they look to accommodate and exceed the expectations of their stakeholders, they are more likely to cultivate an institutional context that supports the development of resources associated with environmental capability. These observations lend weight to the following proposition:

> 4b. A firm is more likely to develop the capacity associated with environmental institutional capital when it can demonstrate a proactive relationship with its stakeholders.

3.7 Chapter Summary

This chapter has built on the analyses of the extant literature and has focused through a series of propositions, the areas in which research will be undertaken. These propositions are summarised in Figure 3.3 below.

Resource Characteristics: Pollution Prevention
1a. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of **Total Quality Management**.
1b. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of **'green teams'**.
1c. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of **employee involvement**.
1d. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of **environmental awareness**.
1e. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of **environmental values.**
Resource Characteristics: Clean Technology
2a. A firm will be more likely to develop a clean technology capability when it can demonstrate the resource characteristic of **cross-functional working**.
2b. A firm will be more likely to develop a clean technology capability when it can demonstrate the resource characteristic of **Design For the Environment and Life-Cycle Assessment**.
2c. A firm will be more likely to develop a clean technology capability when it can demonstrate the resource characteristics of **partnerships and collaboration.**
Moderating Factors
3a. The development of pollution prevention and clean technology capabilities will be moderated by **non-environmental organisational strategies**.
3b. The development of a pollution prevention capability will be moderated by a firm's **track record on environmental issues.**
3c. The development of a clean technology capability will be moderated by a firm's **experience with innovation.**
Selected Elements of Environmental Institutional Capital
4a. A firm is more likely to develop the capacity associated with environmental institutional capital when it can demonstrate a **proactive relationship between its operational activities and the natural environment.**
4b. A firm is more likely to develop the capacity associated with environmental institutional capital when it can demonstrate a **proactive relationship with its stakeholders**.

Figure 3.3: Summary of Propositions

I have established that the extractive sector and in particular mineral production, would be a useful arena in which to make a contribution to research on environmental capability. I have argued that in order to expand our knowledge of environmental capability there is a need to address our analysis at the level of the resource characteristic which, may be empirically investigated. The pertinence of each characteristic, as outlined in a theoretical context in chapter two, has been supported by additional empirical examples.

I have proposed that in exploring the links between resource characteristics and capability development we would gain an improved understanding by addressing the potential for factors internal to the firm to moderate this relationship. The discussion has suggested that while researchers have pointed to the existence of these moderating influences, limited empirical work has been undertaken to investigate these suppositions further. Finally I have made the case for taking into account organisational context. Specifically, I have argued that the presence or absence of key elements of environmental institutional capital (Oliver, 1997) may act to either enhance or inhibit environmental capability development. The relationship between the propositions is illustrated by the conceptual framework, Figure 3.4.

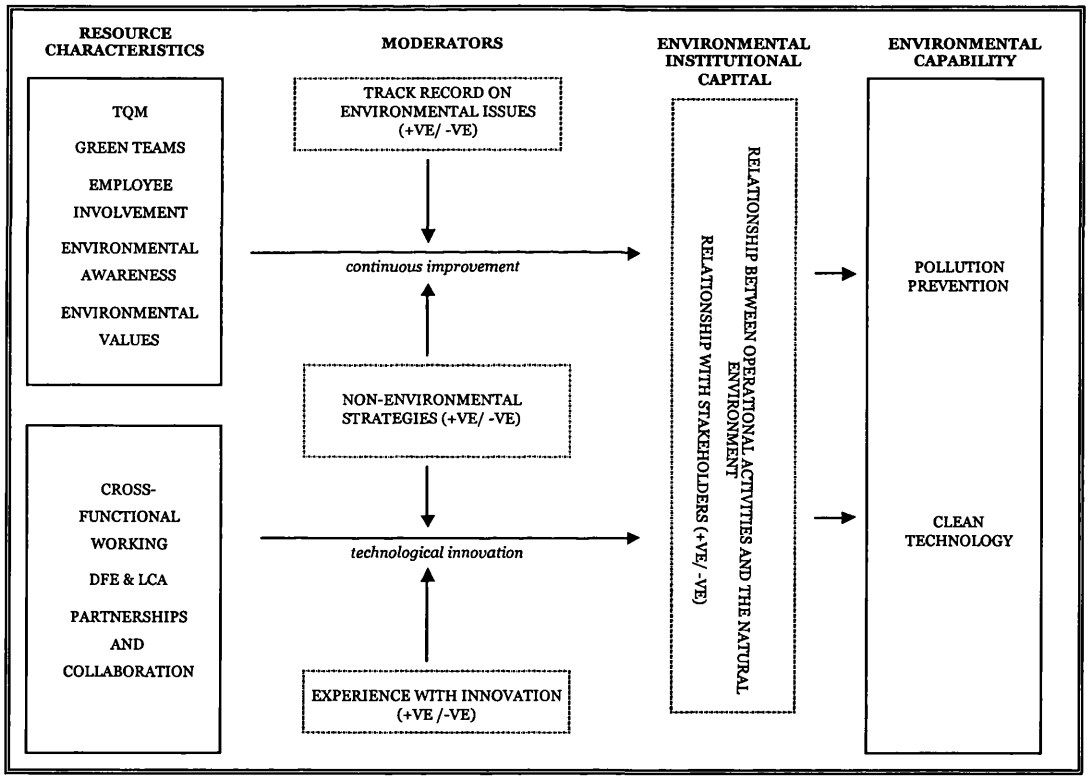

Figure 3.4: Conceptual Framework

Chapter Four: Research Methodology and Methods

4.1 Introduction

This chapter describes and explains the research design that has guided this project. I begin by outlining the research paradigm that has provided the philosophical basis for the work undertaken and that has also directed the choice of research strategy and methods. While, at first sight the research design reflects logic associated with positivist research, subsequent discussion will indicate how the research is driven by more pragmatic influences that favour the integrated use of quantitative and qualitative methodologies. The chosen case-based research strategy is presented as being the most appropriate for the phenomena under investigation, and additionally its use reflects an analysis of the extant literature and identified methodological gaps in this area.

I continue by illustrating and discussing the main methods (interviews and a questionnaire) and the supporting methods (documents, archive material and observation) used for data collection. The advantages and disadvantages of using these methods are considered, in particular where they represent the primary sources of data. It is argued that, potential inadequacies in the methods employed can be overcome by a combination of researcher integrity, and an established chain of evidence. In order to illustrate how the data have been analysed and interpreted I provide an introduction to the techniques used that relate both specifically to the methods employed as well as to the guiding principles of the research strategy. In addition I consider the key research issues of validity and reliability and indicate how they are best achieved and accounted for in the context of a case study strategy. Finally I discuss how issues of interviewee confidentiality and proprietary company data are handled in this context.

The key stages of the research design, elaborated on in the following discussion, are summarised in Figure 4.1 below.

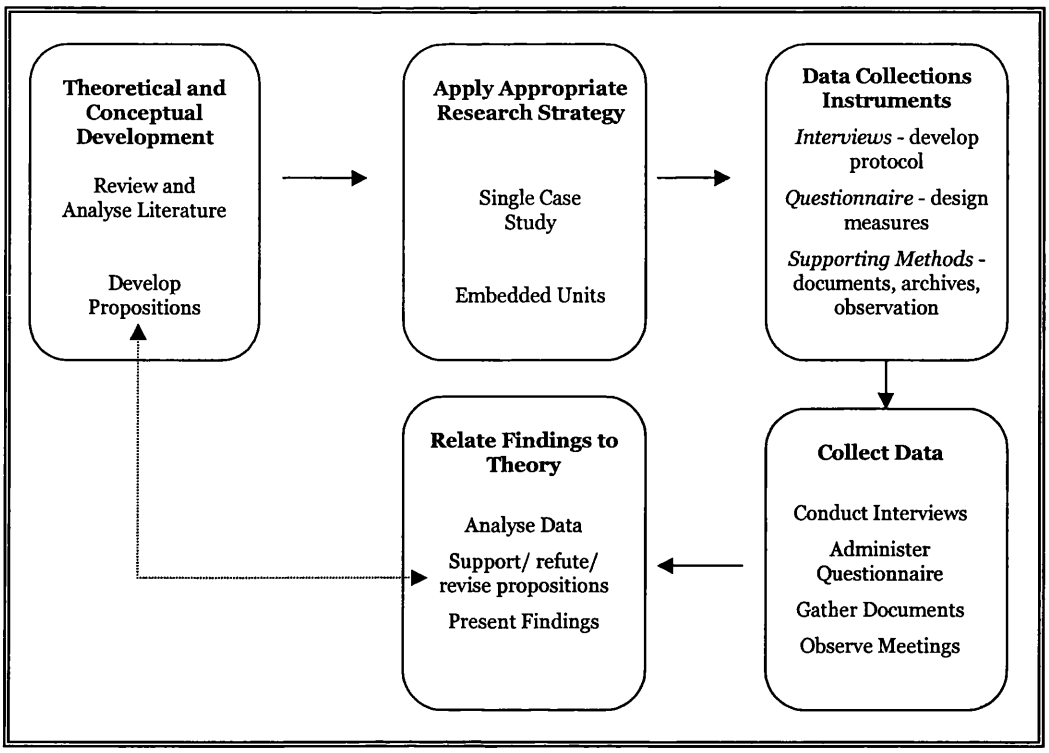

Figure 4.1: Diagrammatic Overview of the Research Design

4.2 Research Paradigm

The relationship between philosophy and the social sciences has a long history. Unlike the natural sciences, social investigations have never disentangled themselves from philosophical concerns. In fact as Hughes and Sharrock (1990) note, it is philosophical issues that continue to provide the fundamental questions asked by social disciplines and that guide investigative rationale. This is particularly true of research in an environmental context where the evolving field of environmental philosophy is asking questions about why and how we should value the natural environment. It is these debates surrounding the intrinsic and the instrumental value of nature that will ultimately filter through environmentally oriented research, to shape the way we formulate policy and develop management practice (Light and Katz, 1996).

The cultures of inquiry, or working models of knowledge that researchers use to explain and understand reality, can be described on of a number of philosophical axes. Recognising and understanding a particular worldview has been important for researchers as situation within a particular paradigm has tended to suggest the use of commensurate methods and techniques. For a significant period, discussions and

debate in the social sciences have been dominated by the 'paradigm wars'[1] between the positivists and the constructionists. Although these positions have arguably become stereotyped over time, they continue to exert significant influence over the way research is conducted in the social sciences (Easterby-Smith et al, 1991). The differences between perspectives have typically been characterised by a split between quantitative and qualitative methods and have essentially been played out in relation to three key areas, *ontology* (the nature of reality) *epistemology* (the relationship of the knower to the known) and *axiology* (the role of values in inquiry). It is not the intention of this discussion to pursue this debate, which has been well rehearsed in the literature (Reichart and Rallis, 1994). Rather, I seek to illustrate that one of the outcomes of this protracted argument has been the emergence of research approaches that seek to distance themselves from this dualism and instead, make creative use of the debated contrasts.

4.2.1 Multiple Methods and Pragmatism

An investigation of inquiry approaches in the social sciences, suggests a growing acceptance of the use of multiple methods. Using mixed methods at different stages of the research process has progressively challenged the mono-method research associated with the polar positions of the competing paradigms (Tashakkori and Teddlie, 1998). Reconciling the use of qualitative and quantitative data in the same study received significant support through the emergence of triangulation techniques. Proponents of triangulation borrow conceptually from surveying, where the measurement of the angles between two points, is used to determine the distance to a third point. Patton (1990) in particular, popularised this notion that it was possible to combine data sources when studying the same social phenomenon. The concept of triangulation can be used in a number of ways within a study. Denzin (1978) suggests that as well as data triangulation, investigator, theory and methodological triangulation can also be used to investigate a research problem. As I indicate subsequently, in case study research the triangulation effect achieved by using multiple sources of evidence is considered an important measure of construct validity.

[1] The use of the term paradigm stems back to the work of Thomas Kuhn (1962) and has been characterised at three levels. The philosophical level which reflects basic beliefs about the world, the social level, which provides guidelines about how the researcher should conduct their endeavour and the technical level which involves specifying the methods and techniques used conducting research (Easterby-Smith et al, 1991).

The use of mixed method research is now seen as increasingly relevant for 'real-world' (Robson, 1994) and management (Easterby-Smith et al, 1991) research that deals with contemporary situations that demand a more flexible approach. Significantly, authors have argued that the paradigmatic dominance of forced choice, 'either-or' methods is neither realistic, or necessary, to produce good research (Tashakkori and Teddlie, 1998). Rather, the increased use of mixed method and mixed model studies has led to a growing number of authors arguing for the adoption of a *pragmatic* paradigm that can both accommodate and justify these choices. For many authors paradigmatic considerations remain paramount (Guba and Lincoln, 1994) and as noted above, philosophical issues have tended to act as the primary guide in social research. In contrast pragmatists have eschewed what they consider to be the 'tyranny' of method' (Bernstein, 1983). Put simply:

> "... we believe that pragmatists consider the research question to be more important than either the method they use or the worldview that is supposed to underlie the method." (Tashakkori and Teddlie, 1998, p. 21)

Therefore, with the research question acting as a guide, pragmatists will select a method or combination of methods that they believe best addresses the problem in hand. Similarly, rather than relying solely on either inductive or deductive logic, pragmatic researchers recognise that research questions may fall at a point along the research cycle that requires both elements of reasoning. The pragmatic treatment of epistemology, ontology and axiology is illustrated and compared with the more traditional research paradigms in Table 4.1.

Clearly as Tashakkori and Teddlie (1998, p. 31) argue, pragmatism has an intuitive appeal because it embraces mixed methods, abstains from using the metaphysical concepts that have caused conflict in the social sciences, and presents a 'practical and applied' research philosophy.

Paradigm	Positivism	Postpositivism	Pragmatism	Constructivism
Methods	Quantitative	Primarily quantitative	Quantitative Qualitative	Qualitative
Logic	Deductive	Primarily deductive	Deductive & Inductive	Inductive
Epistemology	Objective point of view. Knower and known are dualism	Modified dualism. Findings probably objectively true.	Both objective and subjective points of view	Subjective point of view. Knower and known are inseparable.
Axiology	Inquiry is value free	Inquiry involves values but they may be controlled	Values play a large role in interpreting results	Inquiry is value bound
Ontology	Naïve realism	Critical or transcendental realism	Accept external reality. Choose explanations that best produce desired outcomes	Relativism
Causal linkages	Real causes temporally precedent to or simultaneous with effects	There are some lawful reasonably stable relationships among social phenomena. These may be known imperfectly. Causes are identifiable in a probabilistic sense that changes over time.	There may be causal relationships, but we will never be able to pin them down.	All entities simultaneously shaping each other. It is impossible to distinguish causes from effects.

Table 4.1: Pragmatism and the Key Social Science Research Paradigms Compared (source, Tashakkori and Teddlie, 1998, p. 23).

Nevertheless, this research approach is open to criticism. To effectively 'borrow the best parts' of conflicting research paradigms while side stepping some of the more controversial elements may be seen as intellectually inferior and inherently less rigorous. Comparing the results and quality of research that uses a more liberal approach could also be considered difficult where other studies have adhered more closely to conventional protocols. I am not arguing here for a wholesale adoption of the pragmatic paradigm. However, there are a number of elements including the nature of the research problem and the personal preferences and competencies of the researcher, that make this more inclusive approach appropriate for the research questions addressed by this study. This is a view supported by Bryman (1989) who argues that the advantages of blending methods in organisational studies are considerable.

4.2.2 Choices and Preferences Guiding Research

It has been influentially argued that researchers should be up-front about their personal preferences and affinities in a research context (Miles and Huberman, 1994). By stating orientations at the outset, the reader is more able to follow and understand the construction of a research report especially when the researcher has deviated from or adapted, established research traditions. My perspective as a social scientist 'in training' is that research cultures or paradigms appear to be shifting. I have suggested above, that the emergence of pragmatism, which is drawn from the early work of American scholars[2] is part of this change. Datta (1994) supports this view, arguing that contributions from the two dominant paradigms actually share common ground having been taught and used simultaneously in the social sciences for years. Datta (1994) further suggests that coexistence may in fact lead to the evolution of a new perspective termed 'adaptive evaluation'. Bentz and Shapiro (1998) similarly note that the increasingly interdisciplinary nature of the social sciences means that the boundaries between paradigms are becoming blurred. It is more appropriate, they argue, to match the approach to the problem such that the researcher is comfortable and therefore capable of producing good data, rather than slavishly following tradition for the sake of perceived methodological stringency.

With a background in the environmental sciences, I have no *a priori* affinity to the research paradigms outlined in Table 4.1. My instincts are to apply a combination of quantitative and qualitative methods as appropriate to the research questions, which suggests a pragmatic orientation. In mapping out the research problem through the development of propositions in chapter three, I use a primarily deductive logic. This reflects both a practical desire to frame and limit the research context to manageable proportions and also a belief that we inevitably approach a problem with knowledge that is the product of social and historical actions, and therefore laden with theory. Using deductive logic to formulate the research problem does not however discount the possibility that new, unforeseen explanations may emerge from the data and as such these observations may led to the induction of alternative explanations.

[2] See for example Rorty. R. (1982). Consequences of Pragmatism. Minneapolis: University of Minneapolis Press and Joas. H. (1993). Pragmatism and Social Theory. Chicago: The University of Chicago Press.

Significantly, the notion that deductive and inductive logic may work together more cyclically, rather than in a linear fashion, has been recognised as potentially useful in the study of greening phenomena. In a discussion of research methodologies as applied to studies of greening Saether (1998), argues that the multidisciplinary nature of environmental research demands a flexibility of approach that is more dynamic in the linking of evidence and theory. This 'retroduction' the author suggests may hold advantages when trying to build bridges between the deep structures and empirical patterns that emerge from case studies (Saether, 1998).

By embracing quantitative and qualitative methods I am implicitly acknowledging both subjective and objective points of view. For example, by using a questionnaire survey I limit interaction with the subject being studied suggesting an objective construction of reality. However, through interviews and conversations I am explicitly interested in the ways that actors perceive their situation, which affirms the importance of the subjective and the notion that meanings are socially constructed and understood. As Miles and Huberman (1994) maintain, this more modern blurring of the lines between epistemologies allows researchers to work more practically across these different perspectives.

This study derives its research questions from the literature and in doing so I have avoided being too driven by my own values in terms of defining the research problem. This can in part be considered deliberate as much environmental research has recently be criticised for being predominantly prescriptive and almost evangelical in its outlook (Newton and Harte, 1997). Nevertheless, I believe that even when the researcher takes steps to be critically self aware, values continue to play an important role in the interpretation and reporting of research findings. Therefore while I make endeavours to control the influence of values in framing and constructing the research problem I recognise that interpretation has the potential to be value bound. Again, in drawing from across the perspectives my research approach exhibits elements of pragmatism.

This section has outlined the nature and context of philosophy in social science research. I have introduced and described some of the key features of an emerging research culture that views the world and the ways in which we can undertake research through more pragmatic eyes. By stating my personal and philosophical orientations in the context of social research I have illustrated how the position I take in this study

resonates with the more inclusive stance taken by pragmatist researchers. This worldview is an accepted and important part of social and environmental research and is illustrated by the increasing number of mixed-method and mixed-model studies being undertaken in the social sciences (Tashakkori and Teddlie, 1998).

4.3 Research Strategy

The research strategy is a mechanism with which to structure the inquiry, essentially a route map for conducting and completing the study. Although some strategies continue to be inherently associated with particular traditions of inquiry, for example the survey with experimental, positivist design or ethnographies with phenomenological approaches, increasingly as I have suggested above, strategies are being used across perspective boundaries. As a result, and perhaps more realistically in the context of contemporary research phenomena, strategies are being chosen in relation to circumstance rather than ideological commitment. This means, as Robson (1994) notes, that researchers are extending their choice to include hybrid designs that are multi-method. Importantly though, strategies should ultimately be driven by the purpose of the study (exploratory, descriptive or explanatory), and the research questions. Additionally, factors such as the degree of control that the investigator has over the phenomena and whether the focus is contemporary or historical should also be considered. Taking these elements into account, this study adopts a *case strategy*. The rationale and appropriateness of this choice are discussed in more detail below.

4.3.1 A Case Study Approach

In his influential account of case study research Yin (1994, p. xiii) remarks that the case study, "has long been stereotyped as the weak sibling among social science methods." Typically he notes that criticisms have focused on the tendency of cases to produce long documents, the limited basis for scientific generalisation from the studies and a perceived lack of rigour. However, Yin's (1994) progressive development of the case method together with creative contrasts from Stake (1995) has elevated the status and perception of the case method in social research. In addition, if we examine recent environmental texts (DeSimmone and Popoff, 1997) or reflect on past organisational studies (Eisenhardt, 1989) it is possible to discern that case approaches have been extensively used. While extensive use does not necessarily confer methodological rigor, it does point to a progressive refinement and honing of techniques (as Leonard Barton

(1990) illustrates in an analysis that builds on, and develops, the case approach). It is this strengthened, more robust approach to case study that serves as a framework guiding the path of this research project.

In chapter three I outlined in detail how this study is concerned with understanding the development of environmental capability. In order to do this I advanced a series of propositions based on an analysis of the extant literature. This linear-analytic approach which is reflected throughout the thesis, fits closely to Yin's (1994) advocated, structured approach to case study. In particular, the author argues strongly for prior theory development, which he suggests assists in structuring data collection and analysis, and is also beneficial should analytical generalisation be sought. I have suggested that empirical investigations of environmental capability are relatively new and that in order to broaden our understanding we need to consider and explore this concept in an organisational setting. I have also identified that the relationship between the concept and its immediate organisational context may be significant. These qualities, according to Yin's (1994) technical definition, are best dealt with by a case study inquiry.[3] Additionally, this close relationship between phenomena and context suggests that there may be 'more variables of interest than data points' and case study research has been shown to be an appropriate strategy for this 'technically distinctive situation' (Yin, 1994).

4.3.2 A Single Case With Embedded Units

Case studies can adopt a number of guises with multiple cases proving popular through opportunities to compare data and enhance measures of validity (Leonard Barton, 1990). However, the strength and appropriateness of single case studies is supported both by evidence of historically valuable data in social research gathered on the basis of single studies (for example, Whyte's (1955) classic 'Street Corner Society') and by an evolving methodological rationale (Yin, 1994; Stake, 1995; Robson, 1994). For this study a single case design was selected for a combination of methodological and pragmatic reasons. As Patton (1990) observes, research design choices are necessarily an interplay of resources, possibilities and personal judgement.

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[3] A case study is an empirical inquiry that:

- investigates a contemporary phenomenon with its real-life context especially when;
- the boundaries between phenomenon and context are not clearly evident (Yin, 1994, p. 13).

As a newly emerging phenomenon, in a relatively youthful field of research, environmental capability has yet to be researched in detail. It was noted in the summary section of chapter two that to date, no studies have explored the experiences of a single, specific firm in depth. A single case study would therefore contribute to this area of knowledge.

By focusing on a UK-based, natural resource company the study contributes an insight into an industry that has traditionally been conservatively closed to independent academic interest working from an environmental perspective. The opportunity to study this company, is important both because of its national economic significance, and its local historical and cultural value. These factors suggest that in a social science context the case may have revelatory significance, making the descriptive element of the case equally important (Yin, 1994). These features of the case also make it intrinsically interesting. We can infer from studies to date (Sharma and Vrendenberg, 1998; Hastings, 1999) that the development of environmental capability in natural resource companies may have important implications for future commercial success. Therefore, in a field where the majority of work to date originates from the United States, the opportunity to study a UK company in this industry context has intrinsic value.

This study draws on conceptual insights from the resource-based view of strategic management. Significant, then, is the contention (as discussed in chapter two, section 2.6.3) that work using this perspective, benefits substantially from the depth and detail obtained by focusing on individual firms. By employing a single case approach this study contributes insights at the level considered by researchers to be most relevant for progressing resource-based perspectives in the field of management more broadly.

The conceptual development in chapter three suggested that to understand the development of environmental capability more fully it is necessary to examine a selected range of contextual factors. This implicit appreciation of organisational context is particularly relevant for environmental research, as authors have argued strongly that to understand environmentally driven organisational change and strategy development, it is important to have an appreciation of all aspects of the business (Peattie and Charter, 1992). A holistic perspective that embraces the key contextual elements of the

business is best achieved through applying a single case strategy. As Stake (1995) indicates in his rationale for this form of research:

> "The real business of case study is *particularization* ... we take a particular case and come to know it well ... the first emphasis is on understanding the case itself." (p. 8, emphasis added)

While I am concerned at a macro level with understanding the development of environmental capability, I have indicated that in order to do this, analysis needs to be focused on a series of identified resource characteristics and potential moderators. Consequently, while the case is bounded conceptually by the notion of environmental capability, and practically in terms of selected operations in the UK and United States, for the purposes of data collection analysis the study adopts analytical units that relate to the stated propositions. This *embedded* design (Yin, 1994) is facilitated by considering these units in relation to the organisation's environmental management programme and environmental product innovation activities. These relationships are summarised in Figure 4.2 below.

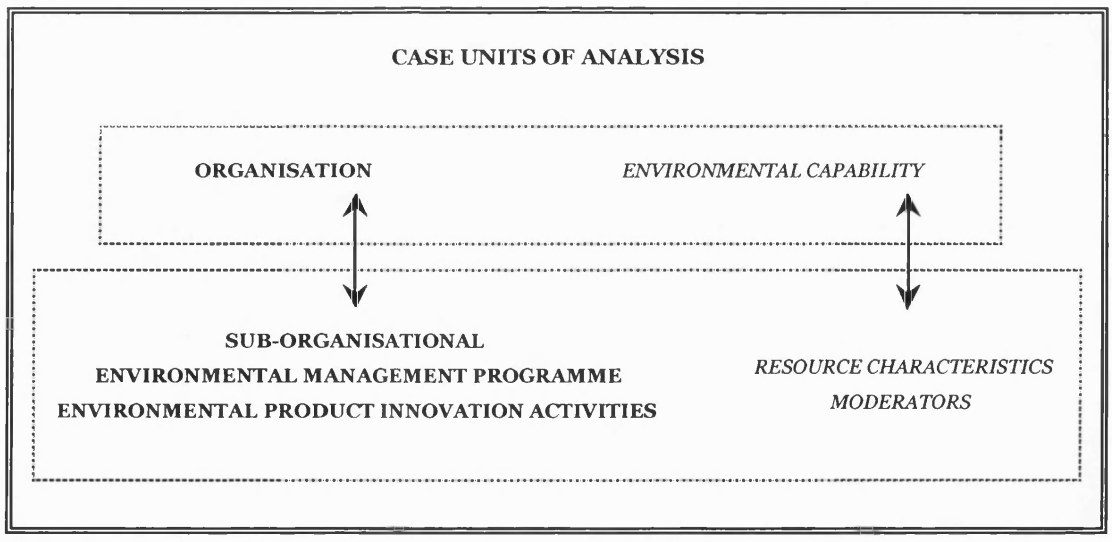

Figure 4.2: A Single Case with Embedded Units of Analysis at Sub-Organisational Level

4.4 Methods

In the previous sections I have discussed both the philosophical orientations for this research and the chosen research strategy. I have outlined that although the research design has a structural logic associated with post-postivisit research, value preferences and design choices suggest more pragmatic influences. In addition I have argued for the option to use mixed methods, which are methodologically accommodated by a case study. This strategy typically relies on multiple sources of evidence and therefore benefits from the collection and use of this data in a triangulating fashion (Yin, 1994). While case research opens the opportunity to use a number of methods, choices need to take into account practical and logistical issues as well as crucially the research questions being asked.

I have already indicated that a single case approach allows us to view in more detail the resource characteristics, that it is suggested, may contribute to the development of environmental capability. Understanding how these characteristics evolve, and gaining an insight into the selected factors that may influence this relationship, is best achieved by talking to those people in the organisation who are involved with and have a perspective on these changes. Interviewing staff is the most direct and efficient mechanism available to achieve this. However the limitations of time and capacity associated with being a single researcher mean that interviews numbers are necessarily limited. A useful way to explore the study propositions more broadly (although admittedly in less depth) is through a survey questionnaire to a wider number of employees. Therefore the primary methods employed to collect data are interviews and a questionnaire survey.

These methods are supported by a significant volume of documentation that was collected and analysed, in order to describe and understand the case more fully. In addition some observation took place during data collection periods. Importantly though, this was incidental rather than methodologically intentional and therefore supplements the primary sources of data only where appropriate. The selected primary methods (interviews, a questionnaire survey) and supporting methods (documentation and observation) are discussed in the next sections.

4.5 Interviews

Interviews are the most widely used method of data gathering in social research and have been described as 'conversations with purpose' (Robson, 1994). However, interviews extend the notion of conversation considerably as they are, by definition, constructed and as such are, to various degrees, systematic and controlled with a particular intention (Sarantakos, 1998). Interviews can seek to ascertain specific facts or be more broadly and deeply concerned with behaviour, beliefs and attitudes. As I discussed in relation to the research strategy, purpose plays an important role in dictating structure and interviews similarly vary accordingly. This means that they may extend from a closed questionnaire style with fixed response choices, to a free-ranging, open-ended exchange that is guided by points of interest as they arise, rather than any predetermined schema. Interviews have several advantages, in that they are one of the most direct and efficient mechanisms for gathering data. They are both flexible and adaptable, and the researcher may also be assisted by non-verbal clues and signals. However, taking advantage of this flexibility demands a degree of skill on the part of the interviewer, who needs to be wary of leading questions and the potential for bias (Bryman, 1989). A further concern in the use of interviews is the problem of interpretation. How can we be sure that we are accurately presenting the organisational reality that the respondent sees? Respondent validation, where the interviewee reviews the script is one possible remedy. Alternatively, the technique used in this study is to check through additional sources by using triangulation methods.

4.5.1 A Semi-Structured Approach

In this study I am interested in drawing out both factual information (for example, in relation to environmental procedures and practices) as well as gaining an understanding of issues such as, how employees perceive environmental concerns and relate to key constituent groups. It is suggested that a highly structured formal approach would be less appropriate for discerning issues regarding relationships and beliefs. Conversely, without guidelines the interviews could be in danger of yielding unwieldy and inappropriate data that would be difficult to analyse. These concerns pointed to the adoption of a central position, using a semi-structured approach. This employs a schedule, but allows for departures should interesting themes (especially those that uncover new perspectives) emerge. It is an approach that has been well used in organisational research, notably by Pettigrew (1985) in his long-term study at ICI, where semi-structured interviews were extensively used. In this study, schedules were

similarly derived from a combination of the relevant literature, focusing in particular on the dimensions of the environmental capability concept outlined in chapter three, and conversations with employees.

The interviews were therefore guided by a protocol and possible prompts that covered the key areas being considered by the research questions, in order to ensure that similar ground was covered in each exchange. A sample of this protocol is illustrated in Figure 4.3, the complete protocol is provided in Appendix i. Nevertheless, the interviews were sufficiently flexible to pursue areas of interest that were specific to the employees' expertise and that appeared to yield new, relevant information.

Capabilities, Resources, Resource Characteristics

• What skills and knowledge has your organisation required in order to address environmental issues?	[process specific, legislative, systems]
• To what extent did your organisation already possess the necessary capability?	[in place, adapted existing procedures, absent]
• How has your organisation gone about acquiring additional capabilities?	[internal development, teams, consultancy, collaboration]
• From where inside the organisation does the impetus for environmental change stem?	[senior, leaders, departments, co-ordinated, *ad hoc*]
• To what extent would you say that environmental issues are integrated into company policies and practices?	[barriers (physical/ perceived), opportunities]

Figure 4.3: Interview Protocol Extract: Environmental Management Programme

In line with the methodological flexibility discussed in the context of the research paradigm above, it was considered appropriate to supplement protocols for second stage interviewing in the company's overseas operations. This reworking reflected both information gathered during the first phase of interviewing, and the contextual differences inherent in different national working environments.[4]

[4] These issues are discussed further in the relevant analysis sections. The supplemented interview protocols are provided in Appendix i.

4.5.2 Data Collection Issues

In developing the interview protocol, issues were discussed with key 'gatekeeper' personnel at the company.[5] This included piloting questions to ascertain their penetration and relevance. In this context, I was particularly concerned with removing any unnecessary subject specific jargon that has a tendency to pepper both management and environmental texts, and that can detract from the clarity of the message. Significantly, this phase also involved some reciprocal learning as the clay industry, in common with most specialised industrial processes, has its own technical and industry-specific terminology. Understanding how people within the industry communicate and function is important in the analysis.

Case studies are renowned for generating large quantities of data and therefore respondents were selected on the basis of both the theoretical constructs of the study, and my knowledge of the case company. As a result, sampling for the interview stage was deliberately *purposive*, it was not statistically determined, and therefore does not make any claims to be representative (Sarantakos, 1998). This non-probability sampling was specifically concerned with the primacy of the respondent and involved selecting:

- personnel who have environmental responsibilities in relation to the company's environmental management programme and;
- scientists and researchers who have been involved in activities to develop environmentally proficient products and processes.

These employees were specifically chosen for their involvement with, and experiences of, company environmental activity. Typically this meant speaking to senior level staff and those with managerial responsibilities.[6] Some 'snowballing' also took place where interviewees recommended other persons who would be willing to be interviewed. This proved useful where previously selected interviewees were unavailable through time or work constraints. This method of sampling was considered the most valuable use of the time and resources available to carry out the research. The resulting sample was drawn from across the organisation functions with an emphasis on the production side of the

[5] Specifically, Mandy Gore, ECCI's environmental scientist and Dr David Skuse, the project's industrial supervisor and senior scientist in Research and Development.

[6] A full list of interviewees in provided in Appendix iii.

business, as this is where the greatest environmental efforts are known to be concentrated.

This study also benefited from the case-research partnership that facilitated access to the organisation. Therefore, issues in relation to access that frequently hinder, delay or prevent organisational studies (Bryman, 1989) were not a substantial concern in this study. All of the thirty three interviews (with two exceptions) were conducted with a single respondent in their office or work environment. Interviews were each of approximately one hour's duration. In each instance permission was given to tape record the conversation and all interviews were subsequently transcribed for analysis purposes. Most interviewees were in my judgement, comfortable and confident with this arrangement and therefore the potential bias or inhibition that some researchers suggest may occur through recording interviews (Easterby-Smith et al, 1991) was not manifest.

This section has discussed the use of the interview method that has formed the primary method of data collection for the study. However, if used in isolation it can be argued that this purposive method of data gathering is limited, as it fails to elicit information from the broader organisational population. Therefore, to maximise the opportunity for data collection a questionnaire survey was also employed.

In the following section I first consider the nature of a questionnaire approach and discuss the advantages and disadvantages of this method. I continue by outlining the rationale for using a questionnaire in this context, and provide details of the instrument construction. Additionally, I raise and deliberate some of the key issues addressed during this phase of data collection.

4.6 Questionnaire

Questionnaires are widely used in social science, as is witnessed by the fact that nearly everyone has experience of being surveyed. Questionnaires aim to measure both facts and opinion. Researchers are particularly interested in the potential for opinions to vary, and it is these differences that questionnaires seek to draw out (Easterby-Smith et al, 1991). More specifically, the questionnaire provides a way of quantitatively linking theoretical categories or concepts with empirical research. As such this method

constitutes a highly structured approach to data gathering. By obtaining data from a sample of people it is possible, depending on the techniques used and the population under consideration, to make inferences about how a larger sample of people would respond. This ability to generalise, relies on the theory that the differences of opinion expressed are 'true' differences (May, 1993). From these differences it may then be possible to discern patterns or relationships through statistical analysis. This search for patterns or profiles means that the focus of analysis is on the characteristics of a population rather than the individual.

Questionnaires, which the respondents fill in for themselves (self-complete or administered questionnaires) are particularly efficient in terms of researcher time and resources as they are relatively cheap to administer and produce quick results (Selltiz, 1976). Nevertheless they are subject to a number of disadvantages (Robson, 1993) which are summarised and compared with the method's advantages in Table 4.2 below.

Self-complete questionnaires	
Advantages	**Disadvantages**
• greater assurance of anonymity • less opportunity for bias caused by the presence of the researcher • offers a stable, uniform consistent measure • can be completed at the respondents' convenience • promises a wider coverage and easier approach	• cannot be certain who has completed the questionnaire • does not allow for probing or clarification • impossible to ensure that question order was followed, possibility of partial response • closed questions are inflexible, open ended questions more difficult to interpret in this format • no opportunity to motivate participation in the study

Table 4.2: Selected Advantages and Disadvantages of Self-Complete Questionnaires (source, Robson, 1993; Sarantakos, 1993; Bryman, 1989; May, 1993).

It is maintained by authors, that most disadvantages can be satisfactorily overcome by good questionnaire design. For example questions should be clear, short and unambiguous, use simple language and avoid negatives (Bryman, 1989). Similarly, careful design, structuring and question ordering can counter problems of

interpretation or partial response (Robson, 1993). A well-designed questionnaire should also allow subsequent researchers to repeat and replicate findings.

However, by asking particular questions, questionnaires presuppose certain relationships and in doing so try to represent opinions in a fixed set of categories. Critical is the need to strive for a situation where responses represent as closely as possible, the way that people interpret the phenomenon under investigation (May, 1993). These concerns suggest the need for adequate preliminary pilot work. Further, there is a need to be critically aware of the notions of causality and the measurement of meaning associated with questionnaires. Questionnaire data often presents causality as an explanation of human behaviour. While it is important to be aware that variables may vary together, this does not necessarily imply causality. It may, however, infer a potential relationship that requires further investigation beyond the existing data. Further, as May (1993) suggests it is difficult to ascertain whether questionnaires can provide satisfactory 'meaning equivalence', a situation where we can understand the researcher's intention and the respondents interpretation to be congruent. However, this criticism could also be arguably levelled at the qualitative interview. This suggests that in research, there is a need to give due regard to the weakness of any method employed, and where possible to triangulate the evidence obtained with other sources of data.

4.6.1 Questionnaire Rationale

I have indicated in earlier discussions, (section 4.5) that interviews are an appropriate method when a depth of understanding is sought. In the context of the resource characteristics being investigated, the interviews purposely targeted those staff most likely to possess more detailed knowledge in the relevant areas. However, purposive sampling is necessarily bounded and meant that in this study, those interviewed were predominantly at a more senior level with management responsibilities. While this was determined as being the most effective way to gain an understanding of the majority of resource characteristics under investigation, it was considered that environmental awareness and environmental values in particular, would benefit from a broader exploration.

In chapter three I argued that environmental awareness is widely considered to be the cornerstone of any environmental management programme. Awareness needs to be

understood as an organisation-wide phenomenon, and it is therefore germane to investigate environmental awareness beyond the confines of one organisational stratum. Similarly, environmental values were discussed as being a core and desirable constituent of organisational culture in the context of environmental capability development. It was proposed that where individual and organisational values are more closely aligned a characteristic of environmental values, that supports continuous improvement, stands an increased chance of emerging. Again, this suggests that values need to be investigated beyond the boundaries of managerial based perception, and that research should aim to encompass a broader cross-section of employees.

A questionnaire is an appropriate method for reaching a large number of respondents across the different functions and levels of an organisation (Bryman, 1989). While the depth of material that can be obtained is restricted by the use of a questionnaire instrument, this was judged to be acceptable in this instance. In particular, the benefit of obtaining an overview of organisational understanding and perception was regarded as a useful counter to the potential for bias from interviewees who operate at equivalent levels in the organisation. Additionally, a questionnaire provided the scope to gain important supporting and contextual data through the use of classification questions.

In retrospect the anonymity of the questionnaire also provided the opportunity for employees to make qualitative comments relating to the company's environmental and economic position. In this context, the questionnaire appeared to provide an outlet for issues that related to the significant period of organisational upheaval and change that was underway during the study period, yielding additional pertinent and complementary data.

4.6.2 Operationalising Concepts

Concepts, as Bryman and Cramer (1997, p. 53) highlight, form the 'linchpin' of the process of social research. Concepts are by their nature abstractions, which makes them difficult to define and investigate. As Sarantakos (1993) notes, trying to investigate even well established concepts such as social class, is difficult if we don't at first try to establish the key elements by which they may be measured. Through the literature review in chapter two, I identified *environmental capability* as an emerging and increasingly important concept operating at the interface between organisational and environmental literature. In order to understand this concept more fully I have drawn

on the work of Hart (1995) in particular, and others, in order to identify a series of observable dimensions (resource characteristics) of this concept. These dimensions provide us with observable elements that allow us to empirically investigate the unobservable concept (environmental capability). I have outlined above that two of these identified dimensions, environmental awareness and environmental values may be most usefully investigated using a questionnaire. In order to do this it is necessary to apply or devise a series of indicators or measures, that can be said to accurately represent these dimensions or in other words, to *operationally define* the dimensions under investigation.

Environmental awareness, though increasingly cited in texts as a key element in the success of environmental programmes (Milliman and Clair, 1996) has not been extensively investigated using quantitative methods. Klinkers and Nelison (1996), report in general terms the results of a company survey that included a measure of environmental awareness, but do not outline the details of their study. For the purposes of this study several simple measures were devised in order to test basic, but essential baseline environmental awareness. The questions use criteria established through environmental impact assessment (EIA) and environmental management systems (EMS) as being important considerations in the siting and operation of any industrial enterprise (Ball and Bell, 1991).

Understanding the potential for operations to impact the natural and social environment is an important step in awareness raising. Impact assessments identify a range of criteria ranging from physical environmental media (for example, air and water) through to social and economic factors (for example, transport and heritage sites). The ability to identify these factors is an important first stage in environmental awareness. Recognising that the significance of these impacts may vary, represents a more advanced stage of understanding (IEMA, 1996). Being able to relate the nature of an organisation's activity with it most significant environmental impacts is crucial to understanding how to prioritise and execute appropriate environmental actions.

Associated with a more advanced stage of environmental awareness is a comprehension that however remote in location, an organisation cannot consider their environmental impacts in isolation (Shledon, 1997). Key constituents can either regulate or influence activities depending on the nature of environmental impact generated (Donaldson and

Preston, 1995). The ability to prioritise those constituents who will be of most concern, demonstrates a competence in environmental awareness. Additionally, identifying that impacts may be experienced and assessed by constituents beyond site boundaries demonstrates a more comprehensive understanding of environmental issues.

Based on this reasoning, the questions devised focus on impact range and significance, the recognition of key constituents, and a spatial awareness of impact potential. The respondents are required to identify (a dichotomous measure) and subsequently rank (an ordinal measure) a series of predetermined criteria as discussed above. A five point Likert scale (an ordinal measure) was used to allow respondents to express their views with regard to the organisation's spatial impacts. The full questions are illustrated in questionnaire in Appendix ii. The rationale of their construction is shown in Figure 4.4, below.

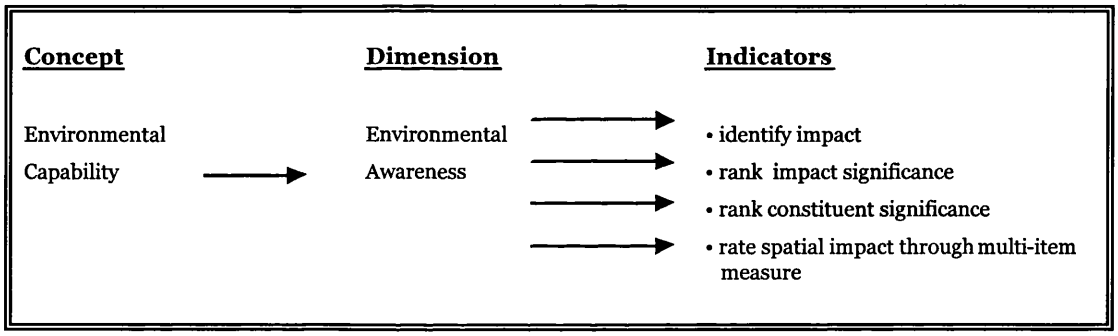

Figure 4.4: Operationalisation of Environmental Awareness (adapted from Bryman and Cramer, 1997).

I discussed in chapter three the proposed importance of values, and particularly shared values, in the context of organisational effectiveness. In organisational research, values measurement has been assisted by Rokeach's (1973, p. 51) operational definition of values as:

> " ... an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence."

Meglino and Ravlin (1998) in their review of values research between 1987 and 1997, show that values measurement has typically been achieved through either normative or ipsative techniques.[7] While each technique has its advantages and disadvantages, assessment of the differences between the two has been equivocal. Ipsative measurement is seen as being particularly useful because forced choice questions tend, according to the authors' assessment, to provide more accurate results (reflecting an individual's 'true' as opposed to espoused values). Whereas, the independence of normative measures allow more ready comparisons of value strengths between individuals. Using a combination of techniques is widely judged to be acceptable. Meglino and Ravlin (1998) illustrate that the measurement of values and value congruence has been significant and widespread in organisational research. Typically where values have formed the dependent variable, studies have focused on cultural values, in relation to ethnicity or race for example (Cox et al, 1991; Whitney and Schmidt, 1997). However, as Hoffman (1993) notes, few studies or primary research have addressed the relationship between individual and organisational *environmental values.*

One key recent study which draws on the techniques developed in organisational research discussed above, and applies them in an environmental context is described by Dodge, (1995). In his original study and subsequent developments Dodge (1995, 1997), develops a series of measures designed to assess the fit between individual and organisational environmental values. For the purposes of this study, Dodge's (1995) measures are adapted and applied. Replicating these measures was seen as useful and valid, both as a test of the measure and, given the similar research settings[8], for future comparative purposes.

Related questions required respondents to rate the importance of particular values (transposed as organisationally relevant factors such as tip restoration and pipeline burst containment) to both themselves and to the organisation. A five point Likert scale was used. A second section, required respondents to rank several predetermined factors which included the environment (based on the company's own published Mission,

[7] Normative measures require respondents to rate the extent to which they endorse a set of items or statements describing a value or set of values. Ipsative measures, typically ask respondents to either rank order a set of values or choose one at the expense of the others in a forced choice format (Meglino and Ravlin, 1998, pp. 359 – 363).

[8] Dodge's (1995) original study was also undertaken in a single organisation, extractive industry context.

Values and Working Principles) from their own and from senior manager perspectives. In addition to these related questions, the respondents were presented with a series of statements with which they could agree or disagree on a five point Likert scale. These statements encompassed the resource characteristics proposed in chapter three. All measures relating to values are ordinal. The logic of operationalising environmental values is illustrated in Figure 4.5.

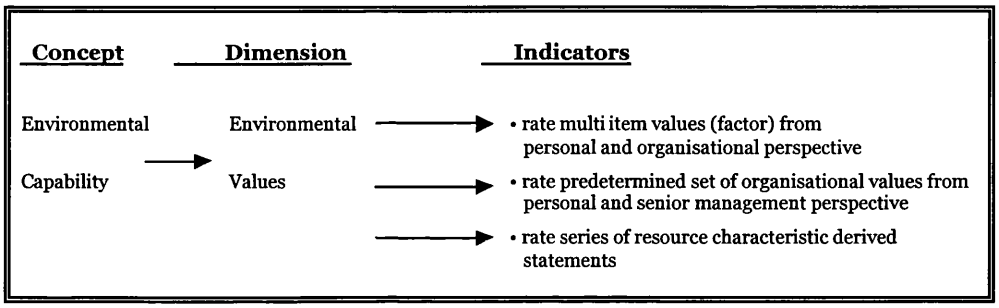

Figure 4.5: Operationalisation of Environmental Values

To assist with classification and questionnaire analysis, a series of questions requesting information about the respondents' department/ area of employment and length of service were included. The full questionnaire is illustrated in Appendix ii.

4.6.3 Selection of Respondents

I noted in the discussion above, that a questionnaire instrument was chosen to support the data gathered by interviewing. The interviews necessarily focused on senior level staff including scientists and managers. To reach a wider cross-section of staff working in a range of functions and at different levels in the organisation, it was considered appropriate to employ a questionnaire. As previously stated this should provide a more thorough understanding of the resource characteristics, environmental awareness and environmental values. By targeting employees at different organisational levels I would be able to look for and contrast potential similarities and differences in the resource characteristics.

In the UK, the case company ECCI employed (during the study period) approximately 3,080 people in its four operational segments around the country.[9] From this target population the accessible population was reduced as the study intentionally focused on the clay operations and associated support and infrastructure services in Cornwall. In an ideal situation I would have opted for a stratified random sample from this accessible population. However establishing a complete sampling frame in this context proved difficult. Ongoing staff changes, due to a significant and prolonged period of organisational change, combined with an increased use of casual and part time labour on the operational side of the business made establishing accurate employee numbers problematic. Additionally confidentiality issues affected access to some company records. This issue of access to a 'pure' sample frame is an acknowledged problem in organisational research for which there are no ideal solutions (Bryman, 1989).

In the circumstances I opted to adapt an existing company database (used for payroll purposes) which encompassed staff in all departments and in all areas of the business, a tactic commonly used by researchers (Bryman, 1989). In order to ensure adequate coverage of all salary levels this database was supplemented to ensure that senior managers not targeted in the interview phase were covered. In addition I opted to administer the questionnaire face-to-face to a randomly selected group of operatives (workers at site level) who would generally not be covered by internal mail databases due to seasonal and shift working.[10] The resulting sample was assessed, in consultation with the company's personnel staff, as providing coverage (at some tiers disproportionate) of staff at all levels in all departments.

There is no single rule to define sample size.[11] Krejcie and Morgan (1970) provide a table for estimating sample size and calculate that for a population of 3000 a sample of 341 is adequate, although it is important to be aware of the assumptions that underlie these estimates. Ary et al (1972), recommend in their discussion of sampling requirements, that researchers select 10-20% of the accessible population for a sample, which for a population of 3000 would be 300-600 cases. These indicators suggest that the final

[9] Figures from the 1998 annual report and accounts, the four operational segment being minerals to paper, performance minerals and ceramics, chemicals, and the corporate centre (ECC plc, 1999).

[10] As well as by factors which remain confidential to the company.

[11] Although it is possible to estimate through algebraic calculation, if one defines the variance of the population, the expected difference and the desired probabilities of Type I and Type II errors (Easterby-Smith et al, 1993).

sample size of 769, falls within the boundaries acceptable for statistical testing. I was however cognisant of the fact that size alone is not a guarantor of accuracy and hence additional efforts were taken to ensure that the sample was representative of the various organisational departments.

Therefore, while making efforts to adhere to recognised sampling guidelines the final sample is most accurately described as stratified and non-random. This form of sampling has been described by Mitchell (1985), as a convenience sample, and authors appear divided as the extent to which samples of this nature are methodologically acceptable. While statistical limitations should be acknowledged, as Bryman (1989) argues excluding research that adopts or finds it necessary to use 'imperfect samples' would mean ignoring a large proportion of published articles including some of the most respected studies in organisation science. What is important, as Mitchell (1985) suggests, is to recognise the potential limitations and make adjustments and checks that take any possible shortcomings into account.

The final response rate from the internal mail over a period of four weeks yielded 409 replies representing a 55.49% response rate, which is considered reasonably high for an internally distributed questionnaire (Robson, 1993). The issue of a non-response bias was considered in relation to a number of factors. The questionnaire was administered during the summer period, typically a holiday period for employees with school age children. Additionally, a recent period of organisation-wide communications and surveys pointed to the possibility of initiative fatigue meaning only those with an intrinsic interest or concern for environmental issues would reply. While this is an inherent concern in 'issue-related' questionnaires, the qualitative data gathered from the questionnaires suggested strongly that a range of opinions were represented in the returned sample and that the response rate was not adversely affected.

4.6.4 Data Collection and Design Issues

In the preceding discussion I highlighted the importance of piloting the questionnaire instrument. For this study I consulted with selected members of staff (a member of the environment team, a research scientist and personnel manager) during the questionnaire development. Attention was paid to wording, clarity and format in order to ensure unfamiliar 'jargon' and potentially misleading phrasing was absent. At these iterative stages, decisions were taken relating to a number of factors including:

- the use of closed questions (an opportunity was provided for open comment at the end of the questionnaire);
- the placing of personal classification questions at the end of the questionnaire, (inverted funnelling) (Sarantakos, 1993; Oppenheim, 1992)

As a result of the pilot work the questionnaire underwent a number of significant and latterly minor revisions.

The covering letter introducing the questionnaire made use of both the University and company logos, which were considered by consultees, to confer valuable legitimacy to the survey instrument. The final cover letter addressed all the key points proposed by authors as being critical in ensuring an adequate response rate, in particular:

- the main objectives of the study;
- details of the researcher and sponsors;
- reasons to complete the questionnaire;
- an assurance of confidentiality and anonymity;
- the requirements/ instructions for completion. (Sarantakos, 1993)

For reasons relating to confidentiality and non-response, on-questionnaire coding was not used. The final questionnaire was printed on three, double-sided A4 sheets, which included the covering letter. The questionnaire took approximately 15 minutes to complete.

To raise response rates, a number of techniques were employed. The questionnaire was 'trailered' using the company's internal, weekly news bulletin, which is posted company-wide and available through email. The bulletin is widely accepted as being an important and well-used source of current company news. To this end it was also used as a 'follow-up' in order to thank respondents and encourage others to complete the questionnaire if they had not already done so. All questionnaires were distributed simultaneously using the company's internal mailing system.[12] Individually addressed envelopes and the

[12] Face-to-face questionnaires were administered concurrently.

inclusion of a return envelope, also using the internal mail service, were provided to assist the response rate.

In this section I have outlined the rationale for, and the design and development of, the questionnaire instrument. In particular, I have highlighted some of the methodological difficulties and potential inconsistencies that arise from conducting research in an organisational setting. In the next section I consider some the supporting methods which were employed during the study and which provide data that is useful for triangulation purposes.

4.7 Supporting Methods

I have discussed above the utility and methodological relevance of using multiple methods from both a pragmatic perspective and in case study research. This use of supporting methods is advocated by Bryman (1989), who argues that in the context of organisational research, method choices frequently represent trade-offs. Adhering too rigidly to mono-method research can he suggests, result in the loss of crucial information. Using supporting methods provides an opportunity to 'fill the gaps', for example, between espoused policy and observed practice. This is particularly useful in strategy-oriented research. This convergence of multiple data sources is also an important source of construct validity in case research (Yin, 1994).

4.7.1 Documentation

Documentary evidence, in its various guises provides important data in nearly all social science investigations and it is unusual for studies to not cite the use of documentary research (Sarantakos, 1993). In case studies documents are particularly important for corroborating and augmenting data from other sources (Creswell, 1998). Documentary sources have a number of practical and methodological advantages. In the main, access to relevant documents is comparatively quick, easy and low cost. It allows the study of past events and its stability means that it can be re-examined as required. Important factual details relating for example, to place, time and participation may also be accurately gleaned.

There are, nonetheless, inherent weakness in documents as data sources. Documents may not be complete, and as they were not intended for research purposes, are likely to

reflect the bias of original intent as well as that of the writer. This means that factors that are neither appropriate, or relevant, to the study in hand will require screening. As a result, caution should be exercised in relation to the reliability of any document. Additionally, comparing documents may not be appropriate.

Nevertheless, documents have become a recognised and valid supporting method, particularly in organisational and strategy research where they have been extensively used (Mintzberg and McHugh, 1985). This study drew on a number of documentary sources, detailed in the Figure 4.6, below.

Summary of Documents Employed

- company annual reports
- published policy documents
- press releases
- company newsletters and bulletins
- internal reports
- internal memos
- internal briefings and presentations
- consultancy and training reports to the company

Figure 4.6: Documentary Evidence

Documents gathered included archive news bulletins detailing company activities and operational practice from the early 1900s to the present day. This material provided important contextual information and an understanding of the chronology of key events in the company's history. Access to these historical company documents, was facilitated by gatekeeper personnel in the company. In addition, periods spent researching at the company provided access to contemporary documents arising from internal sources. These sources included news bulletins and information circulated by electronic mail, as well as official postings and notices made available through company notice boards. This was a particularly significant and valuable source of data during the considerable organisational changes that took place during the study period.

Documents provided in relation to product innovation activities comprised of detail that was primarily in the public domain and therefore did not include commercially or scientifically sensitive material.[13] In collecting documentary evidence I was cognisant of the fact each document had its own purpose, and that there was consequently a need to be aware of the institutional and socio-cultural context of any data gathered.

4.7.2 Observation

Observation is one of the oldest methods of data collection (Sarantakos, 1993) and as such is open to all observable phenomenon. Most research with people and, or in, organisations involves observation in a general sense and the extent to which this becomes an important part of data collection depends on the study design and the questions being explored.

Authors have classified and described the types of observation available to researchers in a number of ways (Robson, 1993; May, 1993). Essentially these explanations differ along three main axes:

- the extent to which the observer becomes a 'total' participant in the phenomenon being studied;
- whether the researcher undertakes data collection in a covert manner, or explicitly states their purpose for being present in any situation;
- methodologically, whether the research is guided by a formal structure or adopts a more informal, unstructured approach to data collection.

Participation may vary from complete immersion where, for example, the researcher becomes an employee or member of the group being studied, to a more detached position where the researcher adopts a recognised 'observation' role that means neither contributing to, or interfering with, the group under observation (Jorgensen, 1989). Covert observation with its concomitant ethical issues, generally requires significant researcher time and competence, whereas observation as an explicit activity is more widely used and can encompass a range of time frames (Easterby-Smith et al, 1991). The extent to which observation is structured will depend on methodological factors (research design) as well as practical issues such as time available to undertake the research.

[13] See section 4.10 for issues relating to secrecy and confidentiality.

Observation has a number of distinct advantages. As people are not asked directly to express their views, it allows them to speak in their own terms. By studying people in their natural settings, the research context is less contrived and it possible to see what people actually do rather than what they say they do (Creswell, 1998). Observation can, however, be time consuming and recording data accurately may be difficult. Additionally, there is always the danger that the researcher as observer can 'disrupt' the natural setting, creating an imbalance or tension that would not otherwise exist.

While these issues are of concern, they are less applicable in a study where observation is used as a supportive or supplementary technique (Robson, 1993). As Yin (1994) notes, in case studies, observation is useful for providing additional information about the topic being studied, something that Creswell (1998) describes as important in trying to gain an understanding or 'feel for' the topic being studied.

In this study, observation was used as a supplementary technique in a number of ways. Field and site visits provided an insight into the processes and activities conducted by the company. Observing the mechanics and technical aspects of the mining operation provided crucial information, in terms of understanding the context that framed discussion with managers. Site visits also provided a spatial awareness that is needed to appreciate the scale and impact of mining activity. Observing the different stages of processing and refining highlighted the practical issues that arise for managers and employees in the development and implementation of an environmental programme.

Additionally, several more structured 'participant as observer' sessions were undertaken. This involved taking part in the first stages of internal environmental auditor training as well as attending meetings of the 'environmental team'. In these situations my role as a researcher was known and recognised by the group and, though mostly passive, did involve some contributions when approached to do so. These situations provided useful opportunities to validate or corroborate messages and perspectives obtained through interview as well as providing first hand experience of the development processes at work.

4.8 Analysis Techniques

Advocates of mixed method studies have progressively looked at the opportunities for using traditional types of analysis either simultaneously or in different sequences (Tashakkori and Teddlie, 1998). Some also employ strategies that involve converting data collected in one tradition to the other. This study does not however, attempt to use data transformation techniques. Rather I have opted to follow a more conventional approach where the different elements of the study are analysed and the data presented within the boundaries of their respective research traditions. More unusually though, the qualitative and quantitative data are presented alongside each other as opposed to being shown in separate chapters. This relates to the complementary nature of the findings and the subsequent facilitation of the discussion.

4.8.1 Qualitative Techniques

Qualitative data analysis has been described as singularly challenging, and experienced academics have argued that there is little which prepares the apprentice researcher for the sheer volumes of data gathered during the course of a qualitative study (Patton, 1990). Various authors have characterised the process of sorting and analysing qualitative material as a 'spiral' with decreasing circles of iteration that lead to an account (Creswell, 1998) or as a 'ladder' where analysis involves climbing a series of stages to reach conclusions (Carney, 1990). What most authors share in common are approaches that move through a series of stages that include:

- organising the data, with notes and files;
- reviewing the content and making 'memos' on early thoughts and impressions;
- reducing the data through the generation of categories;
- ordering the data using visual displays and through the development of categories and codes;
- refining the categories to produce a 'family' of themes that structure the account.

The data analysis in this study followed these recommended process guidelines, with the main qualitative element being captured by the semi–structured interviews conducted. Each interview was first transcribed. This process focused on the substance of the spoken narrative and did not seek to include or analyse the nuances of conversation such as pauses, laughs or interruptions to the interview. Once transcribed, the interviews were read holistically to get a 'feel' for the data without the imposition of

a priori categories. Memos and notes were made in the margins to highlight any unexpected, unusual or key themes. Subsequent analysis benefited, as Yin (1994) suggests is the case, from the series of propositions developed in chapter three with each main category for analysis relating to the characteristic or variable being explored through these questions. Using these main categories, transcripts were then coded and key quotations and sections of narrative were ordered according to these grand themes.

Using these overarching categories as a framework, the data was then subjected to a more grounded approach, which allowed additional issues and themes to emerge from the data. The process resulted in a series of further inter-related categories and sub themes. An example showing an extract of the categories and themes generated for proposition 1d (environmental awareness) is illustrated in Figure 4.7.

Grand Theme	Category	Sub-Theme	Illustrative Quote
Environmental Awareness	**Facets of Awareness**	**Relativity**	" ammonia did cause a problem and there are one or two issues coming up which weren't actually recognised in the past." No. 14
		Legacy Influences	" it is difficult to convince people of the urgency when nothing ever happens, it might be, well I've been here for 30 years and it has never happened yet." No. 14
		Vertical/ Horizontal Variations	"there are an increasing number of people who have an innate interest in the environment, however this is not necessarily integrated into the work environment." No. 7
		Holism Vs Detail	"it is the attitude out on the works, they don't have the big picture." No. 12
	Awareness Raising Methods and their Efficacy	**Experiential Learning**	".. environmental work is widening awareness levels in more people..." No. 16
		Direct Communication	"at least with face-to-face discussion you can tell whether they understand." No. 12
		Targeted Training	"environmental training would be more helpful if it was specific to the things that we do." No. 6

Figure 4.7: Analysis Table Extract: Environmental Awareness

These initial groupings were then reviewed in more detail in order to produce more consistent categories. As a result, some of the weaker themes, with limited supporting

evidence were dropped and other themes with related data were amalgamated. The final themes and categories frame the data analysis in chapters six, seven and eight where each proposition is characterised by a series of explanatory themes. These themes are also illustrated in chapter nine (Figures 9.1-9.4).

In this study the interview data provided the primary qualitative element of the study. Significantly though, as indicated in Figure 4.4 above, additional qualitative materials provided supporting evidence. All documentation and secondary data was recorded and given a basic analysis through the use of document summary forms as recommended by Miles and Huberman (1994). Essentially this involved reviewing the key details contained within the document and recording essential facts, dates and their possible significance. As noted above, the potential for bias in documents of this nature necessitated a 'watching brief' on the contributory value of any data gathered and analysed in this way. This approach did not preclude the gathering of more unusual or archive data (for example 'back copies' of company newsletters) some of which served to provide important contextual material when building a picture of the case.

4.8.2 Quantitative Techniques

While qualitative analysis techniques have an in-built flexibility that is an accepted part of the process, methods for the analysis of quantitative data are less equivocal. Most texts on quantitative data analysis set out a series of protocols and stages of analysis that researchers should aim to follow (Foster, 1998; Bryman and Cramer, 1997).

As noted previously (section 4.6.4) to militate against possible non-response and maintain the simplicity and clarity of the questionnaire instrument, no on-questionnaire coding was used. Therefore as questionnaires were returned they were manually numbered and the data entered into an Excel spreadsheet using a simple coding system. All questions with exception of 11b, which related to job title, were assigned simple numerical codes. This classification question [11b] was transformed with the assistance of the company personnel officer into a series of hierarchical grades. Using an existing pay grading scheme, employees were classified according to four tiers (Hierarchy 1-4, where 1 = most senior and 4= least senior) which involved 'collapsing' an eight point scale. Once entered, data was checked for errors and corrected both on hard copy and by a second party, before being loaded into an SPSS file (Statistical Package for Social Scientists) for analysis.

The aim of the questionnaire was to obtain a broader understanding of environmental awareness and values across the organisation both vertically and horizontally. As such I was looking to discern differences between the way employees in different hierarchies and functions responded to questions, as well as the differences between personal and perceived corporate perspectives. Exploring the differences between three or more samples across one variable is best achieved using a one-way analysis of variance (one-way ANOVA). Texts generally suggest that this test should be primarily used with parametric data which displays a number of predefined traits (it is quantifiable, i.e. more than ordinal, the distribution is normal and the variance of variables is equal) (Saunders et al, 1997; Foster, 1998). In this study the data analysed used an ordinal/ranking scale and for some of the indicators the results show a degree of skewness (both positive and negative, see Appendix iv).

Significantly, Bryman and Cramer (1997) argue that the choice between the suitability of parametric and non-parametric tests is an unresolved debate in quantitative analysis. They suggest that the need to meet the conditions for the use of parametric tests has been strongly questioned, and that parametric tests may be considered robust for data which does not necessarily meet these criteria. This is a view supported by Dodge (1995) from his analysis of the research literature. Calculations and reported significance levels in chapter six therefore refer to one-way ANOVA. Limitations and confidence in the measures reported are discussed in the analysis text.

4.9 Quality in Analysis

In this study I am looking to understand more fully the concept of environmental capability and how it develops, as well as gain an insight into which factors may impinge on that development. An important aspect of the quality process involves establishing and illustrating that the research study has been conducted in an open and honest fashion. The extent to which research may be viewed as trustworthy and unbiased goes beyond intention and presentation (Robson, 1993). More fundamentally, the 'goodness' of any study and its findings are determined by key questions that we ask ourselves during data collection and analysis. For example, as Miles and Huberman (1994, pp. 278-279) suggest:

- Is the research design congruent with the questions being asked?;
- Are the study methods and procedures described explicitly?;

- Are areas of uncertainty identified?;
- Are the findings congruent with, connected to or confirmatory of prior theory?

This need for transparency and the ability to assess research findings has traditionally been achieved through considering work in relation to key criteria embraced by the concepts of *validity* and *reliability*. In quantitative research, from which these terms derive, quality concerns typically become divided and applied to both the measurement and the findings of data. In qualitative research, where the process of measuring or collecting data and analysis often occur in tandem, quality concerns are more frequently considered together (Tashakkori and Teddlie, 1998). In addition, the nature of qualitative research means that quality issues have been extensively debated as the applicability and relevance of criteria derived from quantitative traditions have been questioned (Lincoln and Guba, 1985). While the debate remains ongoing, there is some broad agreement about how criteria developed for qualitative methods may overlap those from quantitative traditions (Miles and Huberman, 1994). These relationships are illustrated in Figure 4.8.

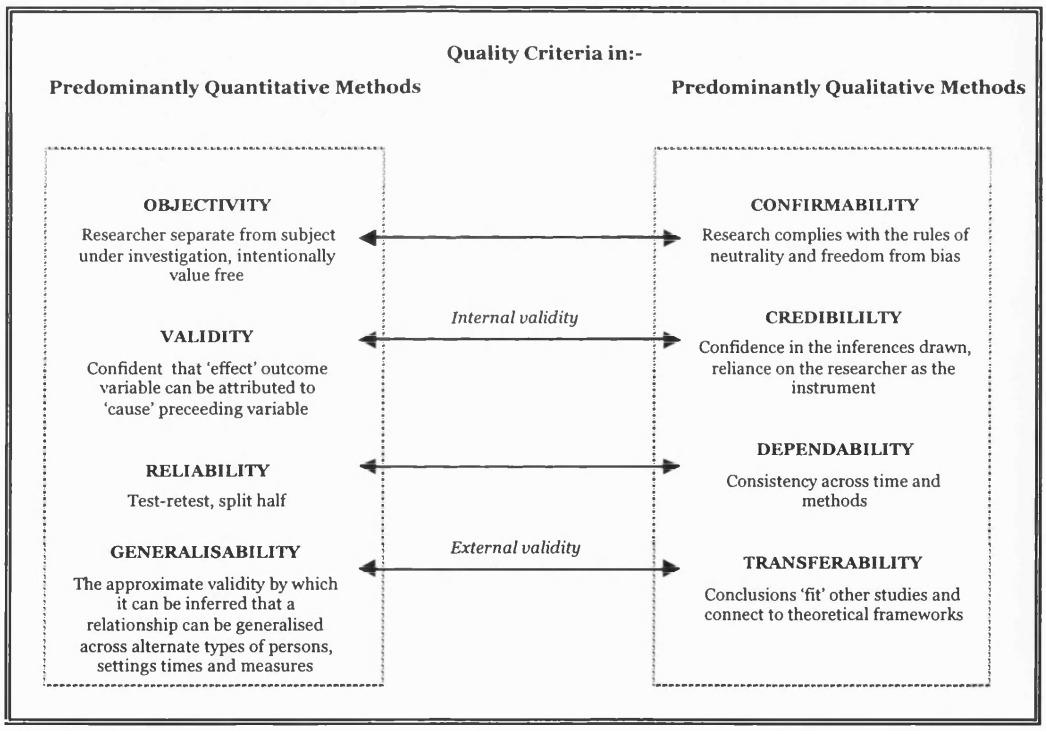

Figure 4.8: Quality Criteria in Research (source Miles and Huberman, 1994; Tashakkori and Teddlie, 1998; Robson, 1993; Saranatakos, 1993).

In the next sections I discuss how quality issues were addressed in this study. First I show how concerns surrounding validity and reliability are dealt with in the context of case study research. Second, I outline how these criteria are taken into consideration when using quantitative and qualitative methods.

4.9.1 Quality in Research Design

Case studies have often been critiqued for a perceived lack of rigour, which Yin (1994) suggests, is largely because the essence of case research has been misconceived. As Campbell, (1975) notes, in case research we can legitimately ask the same questions relating to validity and reliability without resorting to the use of quantification or tests of significance. In considering construct validity it is important to show that the measure of change, does indeed reflect the observed change. In cases, Yin (1994) encourages the use of multiples sources of evidence, with converging lines of inquiry. Throughout this study I investigate propositions from a range of perspectives. For example, studying the development of 'green teams' involved researching documented company evidence relating to team development, talking to managers about their experiences of team working and observing teams at work. Additionally, converging data sources involved 'person triangulation' where comparisons were made between individuals and groups of individuals. Construct validity is also maintained by establishing a 'chain of evidence' (Yin, 1994). In this study the stages of data collection, data analysis and the presentation of evidence are explicitly outlined and described. Therefore, where quoted evidence supports an assertion it is possible to trace both the original source and the logic of collection.

While this study necessarily involves descriptive material it is also seeking to provide explanations for the phenomenon of environmental capability. Consequently issues of internal validity, where it is possible to show that certain conditions lead to other conditions, are relevant. In case research this issue is best addressed during analysis by using the tactic of pattern matching (Miles and Huberman, 1994). As chapter three illustrates, this study relies on theoretical propositions, and in the analysis I therefore compare empirically-based patterns with predicted ones. This explanation through patterns and themes includes identifying possible rival or alternative explanations that may challenge the proposed links contained in the propositions.

The extent to which the conclusions from this study are relevant to other analogous situations is addressed by the concept of external validity. Yin (1994) argues that case research is best placed for analytic generalisation to theory. Certainly one of the aims of this study, is to contribute to our understanding of environmental capability at a theoretical level, in the context of organisational theory. It is nevertheless important to remember that case research is also, as Stake (1995) stresses, about particularisation. That is, learning to understand, describe and explain the case in its own right. While this case is (for the reasons described in chapter five) in many ways unique, as a reflection on the extractive industry it also has a number of generic traits that make it useful for learning about the development of environmental capability in mining and innovation more broadly.

Authors agree that the most effective way of achieving reliability in case research is to adopt and follow a strict case study protocol (Yin, 1994; Stake, 1995). Essentially this requires that each step in the process of data collection and analysis is as transparent as possible in order that it may be repeated in the same context by another investigator. In this chapter I have discussed in detail how the processes of data collection took place, referring where appropriate, to either the appendices or material from the case study database. In subsequent chapters I will go on to describe and analysis the case material and make inferences. Where these inferences are supported by data, the source in indicated. While efforts have been made to adhere to Yin's (1994) acknowledged recommendations, lack of replicability is a feature of organisational research. Ultimately therefore, much relies on the integrity of the researcher and it has been my intention throughout to minimise bias but indicate where possible partiality may occur.

4.9.2 Quality in Qualitative Methods

Creswell (1998) identifies the debate surrounding quality in qualitative research as a complex and emerging area. I have illustrated in Figure 4.5, how authors have found some unanimity with the more traditional measures of quality. Importantly though, in qualitative work the emphasis is with *credibility* and *transferability,* rather than validity as it is traditionally conceived. In essence this means giving a fair and balanced account of the social phenomenon from the perspective of those being researched (Neuman, 2000). As noted above this element of research, which has also been described as *verification* (Creswell, 1998), occurs throughout the course of the study.

Specifically, qualitative researchers have developed a number of tactics for dealing with quality concerns and those employed in this study are outlined briefly below.[14]

Most authors including (Stake, 1995; Creswell, 1994) identify triangulation as an important tactic. In this study as indicated previously, I use both method triangulation and person triangulation to shed light on a theme or perspective. Additionally, I adopt the recommendation of 'thick description' to illuminate the context under study.[15] This is significant, if future researchers working in an extractive context wish to explore further some of the study findings. One of the most critical techniques according to Lincoln and Guba (1985) and Stake (1995) is that of 'member checks', where participants in the study are given the opportunity to review and assess findings. In this study interpretations and conclusions were taken back to key informants in order that they could judge the credibility of the account. These techniques and the provision of detailed descriptions contribute to the transferability of the study findings.

4.9.3 Quality in Quantitative Methods

In section 4.9 I noted that when using quantitative methods, issues of validity and reliability tend to be considered both during the process, and in relation to the end results of research. In other words data is collected and evaluated (validity and reliability) and then the conclusions made after these steps are evaluated in terms of quality of inference (internal validity and generalisability) (Tashakkori and Teddlie, 1998).

At its most basic, any measurement should aim to achieve face validity where the measure, "apparently reflects the content of the concept in question" (Bryman and Cramer, 1997, p. 66). However, when using a number of measures or indicators it is also useful to test for construct validity (the degree to which a test measures the construct) (Tashakkori and Teddlie, 1998). To achieve satisfactory construct validity, any measure should be strongly associated with other measures of the same construct, and unrelated to measures that are not expected to be associated.

[14] Creswell (1998, pp. 201-203) suggests that any study should employ at least two of the following tactics, prolonged engagement and persistent observation, triangulation, peer review and debriefing, negative case analysis, clarifying researcher bias, rich, thick description, external audits.

[15] Case studies rely on detailed description which facilitates an in-depth picture of the case itself and contributes to the development of analytical themes.

The extent to which the result of this analysis can be generalised (external validity) is necessarily limited. It was noted in the above discussion, that while efforts were made to reduce sampling error, a statistically 'perfect' sample could not be achieved. Nevertheless, the results indicated that responses broadly reflected the spread of Cornish UK-based employees and therefore, that, generalisations to this limited population could be considered valid.

As Neuman (2000) observes, it is rare to have perfect reliability. In this study I have used a number of indicators to investigate the dimensions of environmental awareness and environmental values. Statistical measures used to determine this equivalent reliability include the commonly cited Cronbach's alpha. The results of this statistic are reported for each of the indicators used in Appendix iv. For most of the indicators reported in the study, an accepted reliability criterion of 0.7 or above, is exhibited (Bryman and Cramer, 1997). Additional techniques to improve reliability included, the use of pre-tests and piloting as well as building on previously used measures (Dodge, 1995), of the dimensions being investigated.

This section has considered issues of quality in relation to research design and the use of qualitative and quantitative methods. In each area I have outlined how concerns relating to quality have been addressed in this study. I have also implied, particularly in the context of a case design, that these quality strategies are not mutually exclusive and that overlapping strategies offer opportunities to improve the strength of inferences drawn from the data. In the following section I consider some of the ethical issues that underlie social research and discuss how issues that arose during the course of the study were handled.

4.10 Ethical Considerations in Research

Ethics is concerned with the interplay between morals, values and politics (Neuman, 2000). While there are few ethical absolutes, in research there is both a moral and professional obligation to be ethical. Crucially this involves finding a balance between the pursuit of knowledge and the rights of those being studied and society at large.

This study was supported by a CASE studentship which involved collaborative funding between the Economic and Social Research Council and an industrial partner, ECC International (now Imerys). The creation of a partnership through this approach brings both recognised benefits and potential tensions in the course of research (Bell and Read, 1998). It is important to emphasise that while the industrial partner highlighted areas of interest, and indicated where particular research directions and findings would be of value, academic freedom[16] was maintained throughout. This allowed the space for redefinition of the project following initial exploratory research and an uninhibited choice of the most appropriate methodology and methods for data collection.

The industrial sponsor, as the case subject, is therefore named throughout and reference is made to actual locations and divisions of the organisation. All data and material obtained through the course of research (except those documents already in the public domain) are treated as confidential to the organisation and the study. In addition all interviewees and respondents to the questionnaire have been treated anonymously. For example, quoted data may be given generic source titles such as 'manager' or 'operational staff member'. Those who are familiar to the organisation will inevitably be aware of the members of teams which are referred to in the text. However, no individual members are identified and their activities are considered in a group context. As noted previously, all observation was undertaken in an explicit manner where those present were aware of my role as a researcher. Therefore no individual was included in this study without their consent. In undertaking fieldwork in this manner I employed what Miles and Huberman (1994) describe as an essentially utilitarian ethical framework which involves informed consent, fieldwork that seeks to avoid harm and where all reporting is confidential.

Research is often, by its nature, a one-sided affair unless it sets out through methodology to be deliberately action-oriented or participatory. In this study the nature of the studentship seeks to ensure that the organisation benefits reciprocally through the thesis itself, recommendations based on findings and published papers. In a more informal context it is hoped that some participants gained useful insights into environment related developments beyond the organisation. On a number of occasions additional time beyond the interview was spent discussing issues and questions raised

[16] Academic freedom embraces the advance of unbiased knowledge and freedom of expression.

by study participants. If participants were able to draw value from these experiences, then it is possible that the study also delivered some more subtle contributions.

As noted at the outset of this chapter, it is beholden on the researcher to be open about their personal values and beliefs where they may impact research content and direction. To this end it should be stated that, my interpretations and approaches acknowledge the role of values and are driven by an implicit interest in the development of a more environmentally sustainable future for organisations. In conducting research I was, therefore, critically self-aware and consciously neutral, although not to the point of dishonesty when engaged in contentious debates with interviewees. This ability to be self-aware supports Neuman's (2000) assertion that moral positions do not invalidate good research.

4.11 Chapter Summary

This chapter has described and explained in detail, the research strategy employed to undertake this study. I have discussed its philosophical basis and developed the rationale for using mixed methods in the context of case study research. In doing so I have emphasised how the strategy (case study) and methods chosen (interviews, questionnaire, document analysis and observation) have been directed by the research questions and are therefore coherent.

In the discussion of data collection instruments I have drawn attention to potential difficulties that arise when researching in organisations, for example in relation to issues such as sampling. Subsequent concerns relating to the quality of both qualitative and quantitative data gathered are addressed in section 4.9. I conclude by stating how the integrity of the research and the rights of the study participants have been safeguarded.

Chapter Five: The Case in Context

5.1 Introduction

This chapter takes a wide-ranging perspective of the company's historical development and business activities in order to build a contextual picture of the case. In doing so it draws on a range of data sources, in particular archive and documentary material, as well as information gathered during periods of observation in the company. The information presented here is predominantly descriptive, but it also contains interpretative elements that assist in developing an understanding of the case. In the first section I outline key historical developments in the company's life-span which construct a picture of a rich industrial and firm-specific heritage.[1] This highlights significant events and makes specific references to issues that are indicative of a period in the company's history. Next, I highlight a number of important contemporary changes that have influenced company structure and position in the market place, up until the take-over in April 1999 by the French group Imetal (now renamed Imerys). It should be noted that for the purposes of the case and this thesis, that the discussion and analysis reflects the position of the company prior to this take-over. In the third section I reflect on how these strong historical legacies and recent periods of company turbulence have impacted and altered the organisational landscape.

In section four, I outline the company's business environment before discussing in more detail the paper industry, which is both the company's biggest market and (in the context of this project) the business that potentially presents the biggest environmental opportunities. The greatest environmental challenges, as with most extractive industries, stem from the company's operating environment. A range of issues associated with the winning and working of minerals are raised, in turn, in section five. In reflecting on the points considered in both the business and operating environments, I draw out issues relating to relationships with key stakeholder groups that impact the company's operational environment. In summary I highlight the factors that will act as reference points for subsequent analytical discussion in chapters six and seven.

What emerges is a picture of a company with a long and significant history resulting in a legacy that continues to impact to the present day. The economic value of the company

[1] The focus here is on development in the company's UK Cornish-based operations.

regionally, and the cultural ties associated with both the industry as a whole and the company itself, are suggested as being crucial contextual factors when considering environmental challenges and opportunities for the company.

5.2 Historical Development

5.2.1 The Origins of English China Clays

The origins of the china clay industry in the UK date back to 1746 when William Cookworthy first discovered china clay at Tregonning Hill near Helston in Cornwall. This discovery followed an extensive search for a source of china clay in Europe with which to rival the Chinese porcelain manufacturers. Subsequent discoveries saw Cookworthy take out a patent on porcelain manufacture and witnessed the rapid growth of china clay production in the St Austell area of Cornwall and Lee Moor in Devon.

Early industry production of clays focused on the ceramics industry. However, the development of paper making techniques saw paper overtake ceramics as the prime user of china clay (ECC, 1996).[2] In the early part of the 19th century, production was spread between a multitude of small companies, all selling product on the open market (CAU, 1992). With the industry established and production growing, English China Clays Ltd. was incorporated through the amalgamation of three of the largest clay producers who together represented 50% of the industry's output (ECC, 1996). This merger proved beneficial in an industry climate where over-production had witnessed falling prices, and continued weakening demand resulted in difficult trading conditions throughout the 1920s and 1930s (Barton, 1966).

The company consolidated its position in 1932 by merging with two principal competitors to form English China Clays, Lovering, Pochin and Co. (ECLP) thereby increasing their share of production capacity to 75%. This period of growth was also accompanied by a number of industry innovations. In 1923 the first chemically refined clays were introduced, and ten years later the company produced the first calcined clays[3] subsequently called Molochite. The 1930s also saw the company establish a

[2] Clay was first used as a filler in paper, with subsequent development of finer grades as a coating.

[3] Calcination is a process of firing at high temperatures that produces clays with extreme heat resistant properties, used for example in refractories.

research department resulting in the launch of selected particle size (SPS), a coating product for the paper industry that has endured as a best seller.

5.2.2 Post War Developments

The outbreak of war brought radical change to the industry. Forced consolidation by the Board of Trade saw a compulsory reduction of the number of working pits by 50%. Output figures of around 708, 000 tons were reduced by two thirds and exports, which had formed roughly 60% of the company's trade, dropped dramatically (Hudson, 1969). Additionally, consolidation exacerbated some key problems that had developed in the industry including, over-dependency on large numbers of men for clay production, low productivity and the increasingly old-fashioned image of the industry as a whole. Interestingly though, while china clay production fell during the war years, the company's engineering section, based in Charlestown, developed and expanded under the demands of the war effort (ECC, 1958). The expertise developed during this time proved of lasting advantage both in the rehabilitation of pits following the war and as the foundation for a strong in-house engineering competence.

In 1943, the assistant managing director of ECLP John Keay, initiated a post-war development plan for the company targeted at every aspect of the business. The resulting recommendations included mechanising the removal of overburden[4], the universal use of high pressure monitors for washing clay and complete mechanisation of drying and loading. These requirements for mass production and the need for mechanisation were subsequently echoed in a Board of Trade Working Party report which criticised the industry as a whole for being, technically backward, under-investing in research and for neglecting the basic welfare of industry employees (Hudson, 1969).

In 1951, ECLP consolidated its position as the leading china clay producing company by acquiring the remaining assets of the existing Lovering and Pochin interests. Additionally, all ownership of subsidiary companies acquired over the years was transferred to the direct ownership of ECLP. This financial reorganisation supported a new structure that organised the company into four trading divisions china clay, building, quarries and transport. On this new footing the company expanded significantly.

[4] Overburden comprises the soil, stent, and sand that over lies the clay bearing deposits.

By 1955 annual output had reached the 1 million tonne mark and 2 million tonnes per annum was achieved by 1964 (ECC, 1996). Innovations in mechanisation continued with the introduction of pug mill extruders (important for the development of paper coating clays) mechanical sand classifiers, the first computer controlled blending system for clays, and in 1969, the highly significant development of floatation processing which allowed the maximum recovery of clay (ECC, 1996). Acquisitions in America of clay producing interests in Sandersville, Georgia, supported a growing presence of strategic warehousing and marketing of product outside the UK (ECC, 1969). Infrastructure developments included increased export capacity through the leasing of the deep-water docks at Fowey, and the bulk transportation of clay in slurry form using tankers and rail.

Although recessionary periods during the 1970s reduced profit growth, the company continued to diversify with interests expanding to embrace leisure, travel services and oil exploration. The 1980s witnessed a continuation of these trends with interests overseas developing to include new clay treatment plants in Spain and mergers for ECC America that increased the company's calcium carbonate assets. Changing practices meant that the last 'skip haulage systems', used to remove debris, were taken out of service. The company also pushed ahead with more efficient drying by installing new rotary dryers at the drying complex next to the port at Par. In a reflection of improving technology, mica wastes (impounded on land through a scheme introduced in 1972) began to be reworked for clay that could now be profitably recovered using new refining techniques. Services to the paper industry were also improved by the completion of a research and development 'Technicentre' at Lixhe in Belgium. Structurally, in 1986 the company chose to reflect its importance as a key exporter of clay product by renaming itself ECC International. The company's export achievements were subsequently recognised in 1989 through the Queens Award for export. This followed the highest ever record of tonnage produced (3,277,000) in the previous year (ECC, 1996).

However, by the 1990s it was clear that growth was beginning to slow down and adverse economic conditions, as well as increased competition were affecting the company's markets. Consequently, a series of changes instigated by new leadership radically changed the nature and course of the company. These key transformations are outlined and discussed further in the following section.

5.3 Contemporary Change[5]

5.3.1 New Strategic Directions

By the 1990s, the company was experiencing difficult trading conditions. With a depression in the UK housing market and high interest rates affecting exports, the company lost its long-standing place in the FT-SE 100. Although moves were made to redefine the suffering construction section by placing the quarrying and building activities together under ECC Construction Materials, pre-tax profits plummeted to £40M in 1990 from the previous year's figure of £137M.

The appointment of Andrew Teare as the new Chief Executive in July 1990 (head-hunted from the Rugby Group) marked the beginning of significant change for the group. From the outset Teare promised 'fundamental changes to the way the group would be managed in the future', and signalled that there would be no room for nostalgia in the new organisation (ECC, 1990). Shortly after his arrival Teare instigated the first of these changes which involved disposing of a significant proportion of the company's house-building portfolio. In addition, a series of 'non-core' assets (including the oil and gas services IDF) totalling £110M were disposed of during Teare's first year in office (ECC, 1992).

In what was described as a both symbolic gesture, and a need to reflect the international nature of the business, Teare moved the company's head quarters, from the traditional base in John Keay House over looking St Austell in Cornwall, to a new site at Theale near Reading (Lorenz, 1995). Having evaluated that the company was over-manned, the new CEO put in train a major restructuring and cost-cutting programme which saw the Cornish workforce cut by almost 25% over a five year period.

To complement the removal of non-core activities the company launched a successful bid, begun prior to Teale's arrival, for Georgia Kaolin (the biggest of the American china clay companies). Falling share prices and weakening paper markets made this move more difficult, although following a series of anti-trust negotiations, the company paid a reduced price for a fractionally smaller percentage of the business. As a result of this

[5] The data throughout this section draws on archive material from the company, in particular 'ECC's Press' (1990-1999), the formal news magazine for company employees

purchase the company became the world's leading china clay producer. Unfortunately for the business, the paper market continued to follow a recessionary path during this period. As a consequence, the company was in a position where it had restructured around a market that experienced little growth between 1992 and 1994, making trading conditions extremely difficult. Interestingly, this refocusing on clay activities saw the only reversal of this period as the company reverted to its corporate name of English China Clays. The American purchase also resulted in a shift of asset base, with a 60%/ 40% UK/ US split being replaced by a 43%/ 39% split (the remainder being distributed between the company's other European and South American interests). In tandem with these changes, financial restructuring included a share rights issue designed to strengthen the quality of wavering shareholder funds. One of the important developments to emerge from this period was an attempt by senior management to develop a new business culture for the group that was more closely cognisant of profit and margin objectives. This new perspective paved the way for the two further major changes of Teare's tenure.

First, it was announced in 1993 that the company was to de-merge the Construction Materials division. It was argued that the company could no longer sustain this capital demanding business with its cyclical market tendencies. Teare argued that by de-merging the construction division, management would be 'incentivised' to set the business up and take it forward (Lorenz, 1995). Further, shareholders would be given the option of either business. In the event, Camas, as the new division was named, increased its market value to £253M a little over one year after the de-merger (Lorentz, 1995).

Second, the company successfully purchased Calgon, a US based speciality chemicals business. This was partially funded by a rights issue and followed a preparatory period of research into the speciality chemicals industry. It was argued that Calgon's technical base and expertise in water soluble polymers complemented English China Clay's research and development expertise (ECC, 1993). In particular it was viewed that considerable synergies could be realised by combining the respective companies' expertise in their major market, the paper industry. In the company literature, this move was regarded as the necessary foundation for the business to enter a market based on knowledge and added-value, with a service orientation that had the potential to deliver higher margins.

By 1994, the company had changed substantially from the previous decade with a new focus on speciality minerals and chemicals. ECC International was restructured into two operating divisions serving Europe, and the Americas and Pacific respectively. Calgon's expertise in the paper chemical industry was further supplemented by the purchase of EZE Products Inc. in 1994, and the company sought to capitalise on these strengths by combining the paper and paper chemicals businesses in the US. While operating profits grew marginally during this period the business continued to be impacted by the cyclical nature of the paper industry, which slowed expected growth in the speciality chemicals market. Having initiated and pursued a policy of unprecedented change, Teare left the company in 1996 to be replaced internally by Dennis Rediker who had until that point led the American part of the company's operations.

5.3.2 Internal Reorganisation and Consolidation

After several years of rising profits, 1996 witnessed a downturn in both the paper and speciality chemicals businesses. Nevertheless, the programme of restructuring continued unabated. Under this new leadership a number of key changes marked the company's progress. For the first time a business unit organisational structure was implemented, grouped into four global enterprises, paper, ceramics, performance minerals and speciality chemicals. Notably, research and development was reoriented towards core R&D work as well as technical support for the business units.[6] The integration of the chemicals and minerals businesses in the US was placed on a more formal footing by the establishment of a new marketing and sales concept called CheMin℠ designed to deliver a combined package of products to the paper industry. In a push to cut costs throughout the business, initiatives aimed at saving £30M across the kaolin operations were begun. Kaolin assets were also reassessed with a write-down in the value of the Georgia kaolin reserves, following difficult market conditions and increased competition from emerging Brazilian markets. The company also reassessed its ground calcium carbonate assets with some sales and rationalisation.

Significantly though for this period (which also marks the period of data collection for this study), the more dramatic structural changes which characterised the early 1990s slowed down. Instead the focus turned to internal change, with management aiming to

[6] Core R&D staff numbers were also reduced from 70 to 40 during this period (*fn 8.9.97*).

restore the base value of the company. In particular the company looked to generate a sharper market focus by paying closer attention to the needs and demands of customers. This strategy, as exemplified by CheMin[SM], represented a key change for an organisation that had arguably rested on its long standing monopoly position and existing customer base. Additionally, the moves to grow profits included streamlining the business through a series of cost cutting exercises. This process was formalised by the introduction of the 'Continuous Performance Improvement' (CPI) concept, delivered by time-limited teams, addressing key areas of the business on the basis of targets and deliverables (for example, water use and management). New management initiatives were also accompanied by improved communications driven in part by increased consultancy input (ECC, 1999). This new 'change agenda' saw senior management focusing on 'people and behaviour' in order to instil a new ethos of personal efficiency and effectiveness (ECC, 1999). However, the contemporary picture of internal change and realignment in the face of difficult trading conditions ended abruptly with the announcement and subsequent confirmation in April 1999 of the take-over of ECC by the French minerals and metals firm, Imetal. The acquisition of ECC marked the end of an era for the business, reflecting an increasing trend for the globalisation of business interests across the extractive sector.

5.4 Reflections

5.4.1 Stakeholder Relationships

The English China Clays (ECC) story in the early years is one of a family-oriented business closely tied to local traditions and customs. John Keay, a significant figure in the company's history actively perpetuated the family traditions of the smaller clay companies as they were gradually embraced by ECC, building strong cultural allegiances over time. The local infrastructure, of villages, schools and roads and the surrounding landscape was progressively fashioned by the requirements of clay production. Settlements in the clay country therefore became physically, economically and culturally tied to the activities of the company. Early criticisms of poor welfare provision in the industry changed as ECC developed an almost paternalistic position in the community, supporting and funding a range of community activities and projects as well as encouraging the involvement of employees in clubs and local institutions. This

community support, although never formalised in written company policy, continues to the present day.

With improved labour relations, long service in the company became the norm and as a result, generations of families gave their entire working lives in the service of ECC. The importance of the company as a consistent and sustainable employer grew following the rapid decline of the region's metal mining industry and ECC became symbolic of economic wealth in the region.

The dramatic cost cutting measures and the redundancies brought about by restructuring in the relatively recent past had a profound effect on the business and its employees. In particular, the cultural ties established through longevity of service were damaged as economic and social circumstances changed. Although arguably necessary for company survival, the impacts of this period are widely acknowledged to have cumulatively resulted in disenfranchisement of employees on a scale not previously experienced.

Contemporary changes have also unsettled the company's long term personnel stability and continuity. The company's early history is characterised by continuity of service and leadership driven by key figures including John Keay and Alan Dalton. Notably, these two senior figures had been promoted from within the business. In contrast the 1990s saw the external recruitment of Andrew Teare and significant changes to the leadership and structure of senior positions in the organisation. For example, during Dennis Rediker's period running the company in the latter half of the 1990s, over 95% of senior management executives either moved roles or left the company (FT, 1999). While change for a declining company may be an important and necessary part of corporate survival in the long-term, the impact of this turbulence on the positive aspects of continuity (such as the retention of tacit knowledge and in-house expertise) remains open to analysis.

5.4.2 Strategic Change

The company's early history is one of steady growth and diversification around the core businesses of clay production and quarrying. The dramatic changes of the 1990s suggest that while the company had historically been consistently successful, it had stagnated during a period when other organisations were radically reshaping the way they

organised and undertook business. The monopoly position in world markets enjoyed by ECC for a long period had, from the perspective of the customer, bred a degree of arrogance and complacency.[7] Continual growth through diversification has also seen the company acquire capital-hungry businesses with profits continuing to rely primarily on high volume, low margin products. As a consequence, changing market conditions meant the impacts of increased costs and reduced sales were felt more keenly. The overhaul experienced by the company during the 1990s was all the more dramatic as it included not only the service and leisure aspects of the business, but also the de-merger of the construction arm, regarded widely as a company core competence.

A less than favourable analysis of the company's strategic management and direction also emerged during the recent take-over negotiations. Interestingly, although the take-over bid by Imetal was billed as friendly it was accompanied by criticisms of ECC's performance and reflected an outside opinion that in spite of the aggressive restructuring, the group was under-performing. In particular, the company was criticised for failing on several occasions to acquire capacity in the Rio Capim kaolin producing district of Brazil which had been progressively challenging ECC in world kaolin markets (Mining Journal, 1999). It was also considered that ECC had not fully addressed the opportunities accompanying the emergence of ground and precipitated calcium carbonate as alternatives to kaolin (Industrial Minerals, 1999). As a result the company had been left open to competition from the substitutes market and had failed to capitalise on the changing demand of paper makers. Additionally the executives at Imetal suggested that the hypothesised synergies between ECC and the Calgon business had never been strategically tenable (Industrial Minerals, 1999).[8]

These observations reflect the difficulties that ECC has experienced in trying to transform the business from a high volume, low margin extractive company to one capable of growing profits by adding value through increasingly specialised and tailored products. This struggle to find a balance between existing capabilities and the need to develop new skills has been exacerbated by the changing dynamics of a volatile market.

[7] Informal, personal communication of results of an internal survey carried out by ECC.

[8] Imetal chose to divest the Calgon speciality chemical business following the completion of the take-over.

Several themes emerge from this section. First, it has been observed that the company has an historical and cultural significance that extends beyond its economic value to the region. These associations are entwined with the physical and social environment. Second, contemporary changes have redefined the company and it relationships, especially with its most proximate stakeholders. This is particularly the case where traditional ties and continuity have been severed. While longevity and continuity provided the company with its strength and success in its earlier periods these traits have tended to act as rigidities in a contemporary context (Leonard-Barton, 1992).

It is suggested therefore, that while the focus of this project is on the development of environmental capability, it is situated in a company context of strong historical legacies and turbulent markets that have brought significant contemporary strategic reorganisation and change. These factors are pivotal because their influence on both the institutional and competitive contexts affects the perceived need and the capability of the company to invest human and financial capital into projects with an environmental focus. Crucially, several of these issues emerge when I consider factors that moderate the development of environmental capability and influence the establishment of appropriate institutional environmental capital (see chapter eight).

5.5 The Business Environment

In the following section, I outline the key markets served by the company during the study period (1996-1999).[9] As noted in the preceding section, during this time the company had sought to refocus the business by concentrating on the sale of speciality minerals and chemicals through, 'customer focused business units' (ECC, 1996). As previously noted, to achieve this the business was realigned on the basis of four global enterprises, paper, performance minerals, ceramics, and speciality chemicals, as illustrated in Figure 5.1.[10] I therefore briefly consider the markets and products of the speciality chemicals, performance minerals and ceramics enterprise before going on to

[9] As indicated previously, this description reflects the situation at the time of study and is no longer representative of the company as it is currently configured.

[10] During this period the company also changed its reporting structure from a geographical basis (ECC International Europe, ECC International Americas/ Pacific and ECC Speciality Chemicals), to a segmental reporting format which more closely resembled this enterprise delineation.

examine in more detail, key aspects of ECC's most substantial market, the paper industry.

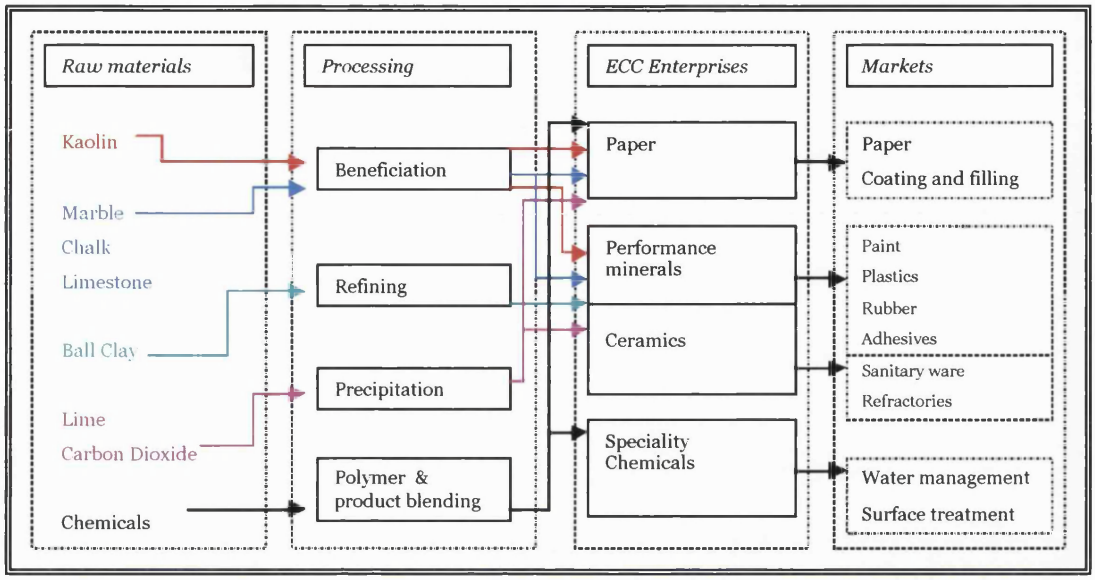

Figure 5.1: ECC Products, Processes and Markets (source, adapted from ECC, 1996).

5.5.1 Market Range

ECC's speciality chemical business consisted of the Calgon Corporation acquired during Teare's term at ECC. The company engaged in water management and the supply of paper chemicals as well as surface treatments and industrial biocides. The markets for these products included industrial and municipal water treatment and industrial processing in areas such as textiles and metals. For example, the company specialised in polymer chemistry that could be used to prevent suspended solids depositing on, and fouling, industrial water cooling systems (Calgon, 1994). For the paper industry, Calgon provided chemicals that assist in both the processing activities of paper production and the effective use of water throughout the paper cycle.

Although Calgon's markets and operations are not discussed in detail here, it is important to note that the CheMin℠ concept highlighted previously, depended on integrating the synergies between this, the company's paper chemical business, and the mineral specialities of ECC. Calgons's established proximity to the market, achieved through a strong, customer integrated sales team, facilitated this approach. Significantly

Calgon was also the organisational 'testing ground' for management and product development initiatives focused on improved customer service, that subsequently rolled-out in the European part of the group during the latter half of the 1990s. The relevance of the CheMin℠ concept is discussed in more detail in the context of environmental product innovation (see chapter seven).

Developments in the performance minerals division, have concentrated business on high quality materials and additives for a range of markets including the paint, plastic and rubber industries. This involves specialist applications rather than volume sales. For example, in the motor industry, the inclusion of clay mineral in plastics has been shown to provide high dimensional stability, gloss and resistance to high temperatures. In building products, calcium carbonate used in PVC-U confers both mechanical and processing properties. Calcined clays improve the electrical properties of PVC and rubber coated wires and cables, as well instilling heat retention properties in polyethylene film used in agricultural greenhouses. This wide range of uses for specially processed white minerals illustrates how innovations in this area have continually expanded market opportunity.

Ceramic products formed the original market for kaolin and although now dwarfed by the demand from the paper industry, ceramics manufacturers have remained an important market for ECC's business. Key product areas for a range of specialist clays extend beyond tableware to include sanitary ware and electrical porcelain, for which the clay mineral is valued for its electrical properties. A key development in the ceramics business was the development of Molochite™ in the 1930s, a product used extensively in the refractories industry for kiln 'furniture' that is required to endure high temperatures and temperature variations. This property of the material means that ECC have also developed an expanding investment casting market serving a range of applications, including golf club heads and turbine blades for the aerospace industry (ECC, 1996, 1999).

Under the new reporting structure adopted in the second half of the study period, it is possible to see more clearly the value of these markets in comparison with the paper business. In 1998 the combined turnover of the performance minerals, ceramics and chemicals business was £357.9M as compared to a turnover figure for the minerals to paper enterprises of £401.3M (ECC, 1998). Although the operating profits of the paper

business were slightly reduced in comparison (£45.7 M as opposed to a combined figure for the other businesses of £50.9M) it illustrates clearly the importance and continued dependence of the company on the paper market. The next section therefore considers more closely the paper market for white minerals and some key aspects of the paper industry.

5.5.2 The Paper Industry

Since the latter half of the 19th century, the paper industry has been the most important market for ECC's kaolin production. Significantly, recent figures suggest that world-wide the paper industry continues to account for 45% of kaolin demand (Roskill, 2000). This sustained market reflects the inherent value of kaolin that derives from a combination of physical and chemical properties. As Murray (1984) highlights, kaolin is a unique industrial mineral because it is chemically inert over a wide pH range, is soft and non-abrasive and, as noted above, has a low conductivity of heat and electricity.

Kaolin has two key applications in paper manufacture as a 'filler' and a 'coating'. Fillers are used both to reduce costs and to incorporate certain physical properties. For filler clays, particle size tends to be comparatively coarse and important variables include the mineral brightness, particle size, the percentage grit and the abrasion number (Murray, 1984). Coatings are used for a number of reasons including improving the receptivity of the paper to printing ink, masking inconsistencies in the original paper, producing a high grade product and reducing abrasion on the paper surface (Harben, 1984). Coating clays are applied as a fine film and are therefore of a finer particle size, with consideration given to the additional properties of particle size distribution, particle shape and the relative shear viscosity[11] (Murray, 1984).

The application of minerals to paper has, over time, become an increasingly sophisticated, scientifically-driven process concerned with developing new grades of clay through a combination of refining and blending processes. Refining technologies aimed at improving the brightness of the product have included the flotation technologies (using chemical flocculation) developed by ECC as well as magnetic separation to remove metals compounds. Achieving the particle sizes required by paper

[11] A measure, impacted by a number of external variables (e.g. the coating colour formula, the amount and type of adhesive), that determines the internal flow resistance of the clay to breakage or distortion.

manufacturers is also facilitated by a process of 'low solids sand grinding', which uses the forces of attrition between sand and the clay slurry (ECC, 1995). In addition the need to ensure consistency in both supply and quality has necessitated laboratory standard monitoring and control of the product. As a result of these developments the production of kaolin has become more efficient and precise. However, there have been a number of changes both to paper making itself and to the market as a whole, which have combined to impact the mineral suppliers. These factors are considered in turn below.

One of the most significant changes influencing the production and supply of kaolin to the paper industry has been the emergence and increasingly rapid acceptance of the white mineral calcium carbonate, as a kaolin substitute. As noted above, the mineral constituent is an important part of paper making comprising up to half the weight of some paper grades (Clark, 1995). The use of white minerals has grown rapidly over the last decade as a result of increasing production of high specification writing and printing paper grades. As paper manufacture was traditionally carried out under acid conditions, kaolin, with its high pH tolerances was the preferred mineral. However, the trend for mills to switch to more neutral and alkaline conditions has spread throughout Europe and North America, facilitating the use of a broader range of white minerals. This situation would not previously have been possible as carbonate minerals would have reacted with the retention agents used in the paper-making process (Greenpeace, 1994).[12]

The growing trend towards alkaline 'running' has resulted in the use of carbonates becoming increasingly popular as paper manufacturers take advantage of their chemical and additional physical properties. Ground calcium carbonates (GCC, derived from chalk and limestone) and precipitated calcium carbonates (PCC, obtained by the dissolution and re-precipitation of limestone) have a high brightness range which is highly valued in paper making. The particular physical properties of PCC (the relationship between mean particle size and specific surface area) may also be manipulated making it a versatile pigment (Linderstrom-Lang et al, 1995). This

[12] Retention agents act to increase the fibre yield of the paper at high machine speeds. Although further developments mean that carbonate filler producers have designed PCC that can be used in acid-based paper-making plants (Roskill, 2000).

flexibility is complemented by the fact that PCC production is not location specific, which allows the siting of PCC plants according to the needs of the end-user, making it an additionally attractive economic option. This popularity for PCC is reflected in industry statistics which have seen a fourfold increase in PCC capacity since 1991, with paper accounting for nearly 50% of demand (Roskill, 2000). The net result of this switch to the use of calcium carbonate fillers and coatings has been an erosion of the traditional market share of kaolin producers from more than 90% to approximately 50% of the filler and coating markets (Clark, 1995). For ECC the difficulties inherent in these changes have been compounded by the emergence of new, high quality kaolin producers in both Brazil and Australia, challenging the more established supplies from Georgia and Cornwall.

With the technical detail of paper-making undergoing change, the nature of the market has also seen some significant shifts during the last two decades. During the 1980s the world's paper and pulp industry began a period of globalisation and consolidation. While the traditional production centres in the Scandinavian countries, Central Europe and North America have remained strong, firms have additionally expanded their interests and established themselves globally. By 1994, 50 of the top pulp and paper firms had production facilities in at least 6 countries world-wide (PPI, 1995). With increasing globalisation there has been a definite trend towards concentration and the increase of segment market shares (IIED, 1996). For example, in 1986 the leading 150 companies accounted for 55% of total world output. By 1993, this figure had risen to 63% (PPI, 1995). These trends have continued, as illustrated by the recent purchase of the US forest product company Champion International Corporation by International Paper Co. (one of the leading US companies). In completing the deal, they outbid another major industry player, the Helsinki based, UPM-Kymmene Corporation (Tanner, 2000).

This growth in the individual market share and purchasing power of corporations has not, however, had a significant influence on a further defining characteristic of the paper industry - its cyclical nature.

> "Paper demand, since it is largely a function of demand for intermediate inputs in other sectors, is closely correlated with GDP growth. As such the industry is sensitive to aggregate business cycles. The effects of these cycles on processes within

> the sector tend to be exacerbated by a 'capacity cycle' with 'lumpy' additions to supply (due to the large scale of modern mills) occasionally getting ahead of market demand." (IIED 1996, p. 24)

In depressed market situations investment in new capacity is limited, particularly as the industry is exceedingly capital intensive and cannot generally invest in new equipment without the support of improved cash flow and access to credit. Although new machinery and capacity can be brought online as prices improve, the lead time for this capital investment (3-4 years for green field sites, but more usually longer time frames for modifications to existing facilities) has frequently coincided with a subsequent downturn in the business cycle (IIED, 1996). These cyclical tendencies have a strong impact on mineral suppliers, as ECC experienced in the latter half of the 1990s. A sustained downturn and subsequent poor recovery of the paper market forced a write-down of the company's American kaolin assets as well as a continued reduction in profits with accompanying declines in share value.

A further key characteristic of the industry has been the exposure of pulp and paper concerns to a raft of environmental pressures which now form a major preoccupation for companies involved in all aspects of paper and paper product manufacture. These issues are briefly summarised in Table 5.1.

Summary of Environmental Issues in the Paper Industry	
Forestry Practices	The use of virgin wood fibre in paper has led to growing concern over the source of wood and the impacts of deforestation and forestry practices. Using principles embraced by the concept of 'sustainable forest management' a raft of measures and policies aimed at protecting landscape, soil and bio-diversity as well as social and economic well-being are advocated.
Energy Use	The pulp and paper industry is the fifth largest industrial energy user globally with energy consumption determined by the type of pulp and paper being produced. For example, thermo-mechanical pulps require a significant amount of energy. The paper industry has used technological advances to moderate energy requirements including, improved mechanisation of the manufacturing process, co-generation of electrical power, and use of exhaust steam and waste to generate power.
Bleaching Methods	Traditional bleaching methods use chlorine compounds to remove lignin and other impurities from wood pulp. Concerns about the industrial use of chlorine in the 1980s (in particular following severe dioxin accidents in the 1970s and the discovery of traces of dioxin in mill effluent) fuelled high profile environmental campaigns to eliminate the use of chlorine from paper production. This led to the

Table cont.	rapid development of elementary free chlorine and subsequently, totally chlorine-free pulps.
Pulp Mill Effluents	Pulp mill effluents contain high levels of organic and inorganic substances in soluble and non-soluble forms. This combination of chemicals and organics, bleach effluents and additives can contaminate and have a toxic effect on aquatic receiving environments. Efforts to improve the quantity and quality of effluent have included recycling process water, reducing fibre and filler discharges and, in some cases, adopting full system closure where effluent discharge is zero.
Recycling	With paper products accounting for a significant proportion of municipal waste in developed countries (e.g. 30-40% in Europe) the paper industry has been heavily criticised for not recovering paper in sufficient quantities. A series of technical and economic constraints as well as inconclusive life-cycle studies on the environmental impacts and benefits of recycling have tended to confuse the debate. Effective policies that are capable of correcting market failures and facilitating recycling are still required.
Waste Management	Although the focus of mill waste generation has tended to be on effluent, mills also discharge emissions to air (e.g. sulphur dioxide, nitrogen oxides, reduced sulphur compounds and carbon monoxide). In the US, mills are now included in the industrial category for major sources of hazardous pollutants. Solid wastes, though normally classed as non-hazardous are also subject to disposal restrictions and costs. To address these issues mills have sought to improve processes and abate gaseous emissions and seek alternatives to landfill (through a combination of methods such as incineration and land application).
Quantity and Quality of Paper Consumption	The reduction of paper consumption forms part of the wider debate on the reform of consumption patterns in the context of sustainable development. This is a complex debate that involves consideration of developed/developing country imbalances, the impacts of the information revolution, as well as the practical, cultural and symbolic value of paper. While the use of recycled fibres is growing, so too is the demand for high quality paper that relies on virgin wood and substantial quantities of mineral to achieve the desired properties.

Table 5.1: A Summary Outline of the Environmental Issues Associated with the Paper Industry (source, Clark, 1995; Linnanen, 1995; IIED, 1996; Lundan, 1997).

As Table 5.1 suggests, the paper industry has been impacted by a broad-ranging and complex set of environmental pressures that have required a combination of strategic, technological and policy changes to the way mills operate. Significantly though, the levels of environmental responsiveness have been markedly variable. For example, in Africa, Asia and Latin America, few mills have replaced their chlorine bleaching technologies with more environmentally acceptable alternatives (IIED, 1996). Even in

North America, where the environmental regulatory framework is more established, mills demonstrate a broad range of responses that include non-compliance. Nevertheless, many large mills, particularly those operating in the Scandinavian countries and Central Europe, have (necessarily) engaged in environmental improvements (MoDo, 1995, 1996). These changes have implications for the mineral producers.

In attempting to 'green' their product lines and achieve certified registration, for example, to one of a number of European and international 'eco-labels', paper companies have pursued environmental concerns (often under the remit of a formal environmental management system) down the supply chain. This form of supplier assessment has implications because of the value of the trade from the paper industry. As noted above, the paper industry accounts for a significant percentage of ECC's custom and with the continued consolidation of the industry this custom has become increasingly concentrated. The leverage potential of this situation in a price context is clear but it also has specific implications for the way that ECC conducts its business in the operating environment.

Additionally, as the paper industry has become increasingly conspicuous (through both interest group and high-profile public and regulatory pressure), the responses, as noted in Table 5.1, have included significant technological advances. The ability to reclaim, recycle and reuse effluent and waste streams has undoubtedly also been driven by the possible cost benefits and material gains of reducing consumption. This recovery of raw materials again represents both a threat and an opportunity for the mineral suppliers who are now increasingly required to engage with these changes as they impact their business. For mineral suppliers such as ECC understanding and pre-empting these changes have become a crucial part of the mineral supply business. Significantly these issues formed the foundation for product and process innovations which I explore in more detail in the analysis sections in chapter seven.

5.6 The Operating Environment

In the previous section, I highlighted how changes in ECC's market environment (in particular those driven by environmental pressures) have the potential to filter down to operational level and impact the winning and working of clay minerals. This customer

interest in the company's operational activities, contributes to the number of constituents who have a perspective and influence on the way the company operates. The following section describes the nature of the company's operating environment, focusing, as indicated previously, on the main European clay deposits in Cornwall. I outline the key stages of the mining process itself before going on to discuss a range of impacts that arise from the mining operations.

5.6.1 The Mining Process

Kaolin, also commonly referred to as china clay, is a constituent of the kaolinite group of clay minerals, one of five clay mineral groupings distinguished by their differing mineralogies. The term 'kaolin' is applied to kaolinitic clays used in applications in which the brightness or whiteness of the clay is important. Kaolin-bearing deposits vary and are characterised broadly by their process of formation, into either primary or secondary deposits. Primary deposits are formed in situ by the alteration of existing granite rocks. This alteration may occur at depth, as is the case in the Cornish deposits, or as a result of chemical weathering in humid and sub-tropical conditions. The relative inconsistency of these processes means that kaolin may be associated with large areas of unaltered granite, as well as variable proportions of secondary minerals. Secondary deposits are formed by sedimentation, usually under fresh water conditions (e.g. the alluvial deposits of Middle Georgia in the US) which has the effect of removing large quantities of unwanted material. Accordingly, the quality of kaolin deposits vary. English kaolins are generally purer than sedimentary clays and this is beneficial. For example, a fine paper coating clay would be expected to constitute 95% kaolinite.[13]

Mining of the primary deposits in Cornwall is achieved in a series of stages. Following exploration and core sample analysis, all mining begins with the removal of overburden which consists of topsoil and some unkaolinised granite. This material is removed to tips and where possible, topsoil is retained for landscaping purposes. Next, the ground is 'broken-up' in preparation for washing. This is achieved by either drilling or blasting rock or by ripping using bulldozers. The most effective way of breaking up the decomposed granite is through the application of high pressure water jets delivered by a powerful hose call a 'monitor' (Thurlow, 1992). Monitor pressure is provided by centrifugal pumps that are remotely controlled and operate between 14 and 20 bar. The

[13] Data source for this section derived from Mineral Guidance Note, prepared for B&Q plc by the author.

water direction is periodically altered in order to maintain a steady stream of china clay, sand and mica in suspension. Faces are worked in 'benches' and the washing stream gravitates to the bottom of the pit, where centrifugal gravel pumps raise the slurry to a sand removal plant (ECCI Ltd., 1995).

Next, spiral classifiers and hydrocyclones remove the coarser sand and mica particles which are removed to tips and mica dams respectively. Refining of the clay stream begins with a settling process assisted by a deflocculant, undertaken in large circular tanks which are 43m in diameter (ECCI Ltd., 1995). The overflow from these tanks feeds a reservoir that acts as a source of water for the washing pumps. The underflow is then pumped to a central refining plant where the stream is refined and classified according to particle size. Table 5.2 illustrates the stages of the refining processes.

Refining Processes Outlined	
Hydroseparator Refining:	deflocculants are added to facilitate the separation of coarse from fine particles, in a series of raked tanks
Centrifuge Refining:	centrifugal forces separate fine and coarse particles
Magnetic Separation:	a powerful electromagnet removes small amounts of mica, tourmaline and iron clays
Flotation:	separates kaolin particles through the addition of a chemical collector which alters the surface chemistry of the kaolin relative to the other constituent minerals allowing the kaolin particles to be floated on air bubbles
Low Solids Sandgrinding:	the attrition of clay slurry with sand to increase the fine clay fraction

Table 5.2 Refining Techniques (source, ECCI, 1993; Thurlow, 1992).

The development of the flotation process by ECC, as noted previously, represented a significant innovation allowing additional kaolin to be separated and recovered from material with high abrasion. The process of refining generates mica residues suspended in water. This waste product, which would cause instability if added to waste tips, is impounded and allowed to settle in large purpose built lagoons (Thurlow, 1992). Surface water from the lagoons is pumped away for reuse and clay is pumped between the various process stages in a slurry via pipelines.

Before entering the dryers the slurry is thickened in receiving tanks, screened for contaminants and pressed through filters to reduce moisture content and associated drying costs. The clay is also fed through 'Pug Mills' or extruders, which act to improve the flow behaviour of the natural clay feedstock (particularly important for coating clays) (ECCI, 1993). The final drying stage using Buell dryers reduces the moisture content of the clay to 10%. Most of the dryers are fired by natural gas.

Significant energy saving has been realised through the delivery of clays in slurry form to paper mills which circumvents the need for drying. Tube presses also deliver a product with a moisture content of 18% suitable for direct shipment to paper mills without additional drying realising an 80% energy saving when compared to traditional drying methods, (ECCI Ltd., 1995). The clay product is ready for sale directly as it emerges from the dryers or tube presses, but specialist clays may require additional refining. Clay is transported in purpose made bags, by lorry container or in slurry form. Around 80% of the finished product is exported through the company's two port facilities at Par and Fowey, with the remainder primarily sold within the UK.

ECC currently produce approximately 2.5Mt of product per year[14] and this high level of mining activity is situated in a relatively concentrated area of around 25 square miles (CCC, 1996). It is inevitable therefore, that these operations lead to a series of impacts in both the environmental and socio-economic spheres. These impacts are outlined in the next section.

5.6.2 Issues Associated with the Mining Process

I noted previously (chapter three, section 3.2) that mining has immediate and significant consequences for the natural environment. The extent to which these interactions need to be managed depends on a complex set of factors that include the geographical and biophysical nature of the landscape, the proximity of the mining activity to local populations and the nature of the institutional and political framework surrounding and governing the operations. In this section, I highlight the key impacts of mining china clay on the natural environment and indicate how socio-economic and institutional elements interact with and influence how these issues are managed.

[14] Competitors also working in the same geographical area, produce a combined total of approximately 1Mt per year.

The mining and processing of china clay has several implications for air quality. Two particular areas are highlighted, dust generation and the production of hydrogen fluoride. A number of china clay mining activities generate dust, including the breaking-up of ground, the transportation of waste and the process of drying. Significant fugitive emission also arise from unvegetated, mica dams and the loading of product at the ports. The methods used to control dust emissions and their relative success is largely dependent on source.

Drying processes are regulated by the local authority under Part B of the Environmental Protection Act (1990), which requires, for example, the calciners operated by ECC to have wet scrubbers and filter bags installed to control dust emissions to 100mg/m3. Health and safety regulations also require levels to be monitored in relation to occupational exposure. The impacts of fugitive dust are typically more difficult to quantify and control, and as such has been addressed by the Cornwall Air Quality Forum through the measurement of PM10 levels in the china clay area. It has been observed that difficulties exist in the obtaining usefully comparable measurements. This is due to the amalgamation of daily readings that produce figures that fail to distinguish between poor or favourable measurements. Readings may also be affected by climatic changes as well as high or peak traffic flows.

The accurate measuring and monitoring of dust is important however, due to its high nuisance potential for residents surrounding china clay workings (for example, through surface deposition). This nuisance factor also has economic implications on a micro scale, for example, through deposition on motor cars or household washing. Efforts to reduce the nuisance factor of fugitive emissions through improved revegetation of bare rock and spoil tips faces have been made by ECC.

However, a growing concern for local stakeholders is the possibility that higher atmospheric particulate loadings of silicate dusts may have implications for human health. Whilst studies have yet to conclusively make these links, the perception that dust generated by company activities may be harmful to local populations is increasingly important both to the regulatory authorities, the local community and the company's workers. The economic and social implications of possible litigation have become a possible growth issue for ECC.

The process of calcination is conducted in kilns at high temperatures ranges of between 500-1500 degrees centigrade. Emissions from the process and chimney exhausts can include hydrogen fluoride. This invisible gas can affect vegetation (and the animals that graze effected land), as well as etching glass. These impacts have the potential to be most pronounced at the point where the emission-plume touches ground. In recognition of this problem, ECC have recently upgraded the scrubber method of fluorine control at their Parkandillick calciner. The transportation of clay by road also has implications for air quality as diesel fumes, in particular, are theoretically more hazardous than mineral dusts. Changes to air quality therefore have potential nuisance and amenity implications as well as possible consequences for human health.

Hydraulic mining by its nature has high water requirements. These needs are met by a combination of groundwater and surface abstractions, the use of company reservoirs and recycling. The volumes used for pit washing are not measured and can vary according to season (for example, greater volumes are discharged during winter months or periods of high rainfall). This industry as a whole accounts for 93% of the total volume of groundwater abstraction licenses and 12.5% of surface water abstraction licenses within the Environment Agency (EA) catchment area.

ECC have twenty consented discharge points in Devon and Cornwall (Pemberton, 1997). Discharges are consented on pH and solids as operations do not discharge heavy metals or organics and consequently company discharges should not affect either chemical or biological oxygen demands. The EA, which monitors water-courses in the catchment, has observed non-compliance in relation to its River Quality Objectives (RQOs), in a series of rivers. Reasons for non-compliance have either related to pH levels or the presence of copper (EA, 1997). While company discharges are essentially inert and do not include metals, the EA have suggested that company consent failures (where they occur) may contribute to the non-compliance of RQOs downstream. In addition to these potential impacts on water quality, the EA also note that the natural beds of water-courses have been in-filled and silted over with sands, micas and clay which depletes the invertebrate population and affects other organisms within the food chain (EA, 1997).

These issues affect the working community and have implications for training, as company employees are required to monitor and manage discharges. To assist this

process several company sites have been used for EA training exercises, simulating 'incidents' (e.g. clay or oil spillage). This incident preparation is particularly important for pipeline bursts where uncontrolled discharge may enter local water-courses.[15] The effects of river discharges both consented and uncontrolled or accidental, also have impacts for local communities who use the area's rivers for recreational purposes. Notable stakeholders include anglers, naturalists and wildlife interest groups.

The production and disposal of waste is one of the most significant issues within the St Austell china clay area. Over time, in the region of 490 million tonnes of waste have been deposited in an area covering 1700 hectares, with current waste production standing at approximately 22 million tonnes per annum (CCC, 1996). The waste produced by the mining process is not uniform. It consists of overburden (soils and subsurface rock), as well as sand and stent (unkaolinised rock). Each waste type is subject to different disposal mechanisms, giving rise to the distinctive landforms including the now historical conical shaped tips. Stent and overburden is tipped by truck, whereas sand is disposed of by conveyor generating, steep-sided benched tips. Mica residues are discharged to purpose built dams from which the excess water is removed and recycled.

The ratio of waste to clay is approximately 9:1. For each tonne of clay produced 1 tonne of micaceous waste, 3.5 tonnes of granular sand and 4.5 tonnes of stent and overburden are generated (DOE, 1993). The issues associated with the siting and disposal of china clay waste are complex and reflect both historical practices and the incremental development of planning regulations. Tip construction has largely been driven by the safety recommendations that followed the Aberfan disaster in 1966. The Mines and Quarries (Tips) Act 1969 required that all tips be engineered and designed with reference to guidelines. Unfortunately the steep-sided nature of engineered tips has made successful long-term restoration difficult, as waste material is typically free draining, with low water-holding capacity and little nutrient retention ability. Engineered tips are also characteristically angular and do not blend with natural landforms.

[15] China clay is transported between processes in slurry form by pipeline. Occasionally pipelines burst or fracture resulting in uncontrolled flows into the receiving environment. These incidents can cause temporary colouration and sedimentation in water-courses.

These problems have been compounded by the historically piecemeal approach to planning which granted applications for small tipping areas without considering the overall landform. In recognition of these issues the Department of Environment commissioned a study in 1990 which addressed the landscaping and restoration requirements of the china clay area. The resulting recommendations of the 'Wardell Armstrong' report in 1993 proposed a 'land-use led' approach that has now been incorporated into the national mineral planning guidelines. Pilot work undertaken by the industry and the mineral planning authority in the Fal Area adopted this methodology.

Although the prospects for the development of future tips have been enhanced, existing tips continue to represent a significant impact on the local community. Tipping has, over time, significantly altered the local topography, influencing micro-climates, changing wind and precipitation patterns as well as in some areas reducing sunshine hours (CCC, 1996). Tipping has also removed or altered the existing built infrastructure of roads and houses. On a local level, housing loss can displace small segments of the population. Road diversions can also have implications for regional transport networks and traffic flows.

In spite of progress by ECC in the development of restoration techniques, fugitive dusts from tips and mica dams remain a significant problem for neighbouring communities. Tips also create a substantial visual impact and have made tipping a source of conflict between the industry and adjacent communities. These issues highlight the impact of adjacent competitor operations which, for example, may not pursue restoration strategies and therefore contribute proportionately greater levels of dust and generate a higher visual impact than tips managed by ECC. However, public objections tend not to make these more subtle distinctions, choosing instead to aggregate industry impacts. These aspects point to the need for careful measurement, monitoring and reporting of performance. Developing successful and sustainable restoration strategies that meet public concerns as well as planning requirements will continue to demand long-term research.

Recognising the impacts of tipping has become increasingly important for ECC as tipping space within the St Austell area is now at a premium and restrictions bring

economic implications for the company, i.e. tipping restrictions can lead to resource sterilisation. Opportunities exist, however, to utilise china clay waste for a range of aggregating purposes including concrete block making, and concreting bulk fill and sand in highway schemes. Unfortunately the wider use of these secondary materials is constrained by both the technical specifications for construction materials and, more importantly, the geographical location of the waste material. The transport costs of delivering to areas of demand continue to make china clay materials uncompetitive in comparison with primary aggregates and militate against the greater use of these secondary materials in construction. Clearly, tipping remains one of the most salient issues affecting the industry and a range of stakeholders at different levels.

The change to the area's habitats is progressive and has become more pronounced as mining has expanded within the confines of the china clay area. Changes in species composition and distribution have inevitably occurred as mine tips have expanded and discharges to air and water have fluctuated. Aquatic life has benefited from industry improvements in river discharges following schemes to impound mica residues on land. However, the issues raised in relation to water quality still have the potential to adversely impact these ecosystems.

The natural heathlands of the upland downs have been particularly threatened by tipping activities. As a consequence, ECC developed a heathland strategy that aims to extend this natural cover to restored tips. These initiatives are however, constrained by the availability of donor areas and the pressure to conserve those remaining areas of heathland intact. Some areas of mined land have regenerated naturally supporting wetland and willow scrub. Unfortunately, the high level of disturbance and deficient nutrient status of the resulting soils has made natural habitat regeneration virtually impossible without assisted, long-term management. Although mining is responsible for habitat destruction, evidence also exists of habitat creation, including nesting sites for birds of prey and protected areas for rare liverwort growth (Pemberton, 1997). Nevertheless the scale of industrial activity means that in spite of restoration activities, habitat destruction outweighs habitat regeneration.

The effect of these impacts on the human environment, is felt particularly, by the local communities. Loss of agricultural land has implications for the farming communities and heathland removal can restrict recreational activity as well as generating a visual

impact. Conservationists' and naturalists' interests are also affected by the changing biodiversity of the region and regulators such as the EA are concerned with monitoring the 'health' of supporting ecosystems. Balancing habitat loss and creation remains an ongoing challenge.

Industrial scale mining and processing activities have the potential to generate vibrations and sounds at volumes greater than secondary or tertiary industries. Vibration can result from blasting carried out to loosen rock prior to breaking and washing. Noise is also associated with pit and processing activities, in particular the drying of china clay. Planning conditions for both the mining and processing elements of china clay production typically specify noise levels (expressed in dBA) for both day time and night time working.

However, within any noise spectrum, persistent sound at certain frequencies can cause disruption. For example the company were required to fit additional acoustic baffels to counter disruptive low-frequency noise from dryers at the Par facility (Pemberton, 1997). These measures were taken in response to complaints from local residents. This illustrates both the cause and effect of noise incidents and in particular indicates how legislative compliant workings can still create effects that impact proximal stakeholder groups.

In this section I have highlighted some of the key impacts and associated issues that arise from china clay working. These issues and their links between operational activities, aspects and effects are illustrated in Table 5.3. In particular, I have drawn attention to a range of stakeholder groups whose experiences and perceptions have a bearing on how these issues are managed. Emerging from this analysis is an understanding that ECC's operational activities are subject to more focused and detailed scrutiny than at any time in the company's history.

Outline of Key Issues Associated with China Clay Extraction				
Issue	***Activity***	***Aspect***	***Effect***	***Stakeholders***
Air Quality	• Overburden & stent removal • Tips • Drying • Mica dams • Transport	• Dust • Fluorine gas • Diesel particulates	• Nuisance • Amenity • Human health	• Employees • Local community • Regulators • Interest groups • Businesses • Customers
Water Quality	• Hydraulic mining • Refining • Drying	• Discharge quality • Incident control	• Reduction in water quality • Sediment loading	• Employees • Local community • Regulators • Interest groups • Businesses • Customers
Waste	• Overburden & stent removal • Refining	• Waste tips • Mica dams	• Topographical alterations • Visual intrusion • Dust blow • Micro-climatic changes • Infrastructure alterations • Secondary aggregate source	• Employees • Local community • Mineral Planning Authority • Interest groups • Regulator • Customers
Habitat/ Ecosystem Change	• Overburden & stent removal • Tipping • Mica dams • Infrastructure alteration	• Habitat, ecosystems and bio-diversity change	• Habitat loss • Habitat creation • Visual impact • Amenity	• Employees • Local community • Interest groups • Regulator
Noise and Vibration	• Blasting • Drying	• Noise • Vibration	• Disturbance	• Employees • Local community • Regulator

Table 5.3: Issues Associated with China Clay Extraction Activities

5.7 Reflections

5.7.1 Stakeholder Relationships

In sections 5.5 and 5.6, an analysis of both historical and contemporary material has shown that the company has experienced marked changes in both its business and operating environments that have in turn affected its relationships with key stakeholder groups. I have identified that while kaolin has a broad and increasingly varied range of

applications, the key market for ECC's product continues to be the paper industry. The high volume of product sold for paper manufacture makes this market particularly significant. This reliance on the paper trade has meant a vulnerability to the cycles that characterise the industry. As important though, have been the additional dynamics brought by the substitutes market and the potential consequences for mineral suppliers of environmental pressures being brought to bear on all areas of the paper product life cycle.

This interplay of factors has stimulated ECC to reappraise the make-up of a relationship that had previously been distinguished by the company's strong dominance in the world supply of white minerals. The change of fortunes for the company (discussed in section 5.3) has arguably affected the power dynamic of this customer-supplier relationship. This is reflected in the more recent shift of focus for ECC to value added products supported by enhanced technical service, as well as strategic-level statements emphasising a commitment to customer service (ECC, 1998). The impacts and implications of this changing relationship context form the backdrop to discussions in chapter seven.

In discussing some of the key issues associated with the mining process itself, I highlighted a number of constituent groups who may be impacted by, or who may have an influence on, company activities in the operating environment (see Table 5.3). Local communities have long existed in close proximity to mine working. Indeed, a number of the villages in the clay mining area were originally constructed to house clay workers. As a result of the strategic changes within the company (see section 5.4.2) the employment and economic circumstances of these local populations has changed. Less employment opportunity has created both disenfranchisement and weakened traditional allegiances. One effect of these changes has been an elevation of interest and concern regarding the environmental effects of mining, particularly those that impinge tangibly on 'quality of life' issues. Objections for example, within the local village of St Stephens to an extension of tipping space at the nearby Gaverigan tip provided a focus for these issues (see Box 8.1, chapter eight). Additionally, it has been argued that the articulation of these concerns is heightened by a changing local demographic that includes 'newcomers' to the area who do not have a history of or first hand experience of living in proximity to mining activity.

The reduction of job security has also tempered company-employee relationships across a number of dimensions. This situation is exemplified by recent health-related concerns regarding the potential carcinogenic effects of silica dusts, and the discovery of radioactivity in the landing lines used to transport clay slurry. Factors such as these have the potential to impinge on an established culture of loyalty to the company and a traditional resilience to the hardships of mine working that pre-date contemporary change in the company.

In discussing the issues that arise as a result of china clay working, attention was drawn to the fact that a number of processes and activities are the subject of regulation by the Environment Agency (EA). The stringency of environmental regulation has developed significantly over the last decade in the UK (Ball and Bell, 1991) driven by an expanding European regulatory framework and supported by a heightened public awareness of environmental issues. As a result, all industrial processes, including extraction activities, are now the subject of closer scrutiny. A compliance-focused regime has necessitated keeping abreast of new regulations, which in turn has pointed towards a more immediate working relationship between the company and the regulator. The nature of this relationship has been determined both by past company experiences of the regulator/regulated interface and the evolution of the company's environmental management plan. These issues, which have been identified as important contextual components in the development of environmental capability, are analysed in more detail in section 8.6, chapter eight.

5.7.2 Operational Change

Although the need to produce increasingly tailored grades of clay has enhanced the refining and blending capabilities of the company, the basic mechanisms of extraction and processing have remained unchanged for many years. The concomitant physical impacts outlined above, including significantly, the large volumes of waste produced, have also been constant factors in china clay production. However some aspects of operational activity have changed.

Over time the number of working pits in the area have been rationalised to increase working efficiencies. However, due to the spatial variation of clays and the geographical limitation of the resources, unworked pits remain dormant rather being decommissioned. This means that while the industry continues to generate large

quantities of waste, the need to avoid sterilising the clay resource (which would occur if pits were back-filled), limits the area available for tipping and compounds the problems associated with limited space.[16] Tipping places the most visibly recognisable pressures on the landscape and communications/ transport networks of the area (CCC, 1996). As such, it has historically been the single most important environmental issue for the company, creating concern for, and objections from, the Mineral Planning Authority and the local community in equal measure. These conflicting issues are reflected in the policy framework for the area which states:

> "The County Council acknowledges the importance of the China Clay Industry to the national and local economy and supports the continued development of the industry to meet market demand within a policy framework, which seeks to protect and enhance the environment, community and amenity, and provide for a *long-term tipping and restoration strategy.*" (CCC, 1996, emphasis added)

Therefore while the physical mechanics of the operations themselves have remained largely unchanged, the management and mitigation measures which are necessary to maintain this status quo have resulted in operational changes, that need to take into account both this policy and the regulatory framework. Examples include, limitations on blasting times, re-routing of trucks from sensitive local road network and significantly the open and consultative planning and development of tips and restoration activity in a manner that takes into account constituent concerns.

This need for shifts in operational practice reflects a new operational context for the company that has been progressively driven by emerging, societal demands, and supporting institutional changes (reflected in the discussion of stakeholder concerns and impacts in the previous section). That these changes have a significant environmental component has been established. Less clear is how the more subtle capability requirements demanded by these changes will develop and perform. It is these aspects that are addressed through continued analysis in the following chapters.

[16] The most recent official figures available show that in the St Austell area the industry occupies 3035ha of which 1108ha comprises pits and 1287 ha tips (CCC, 1996).

5.8 Chapter Summary

This chapter has introduced a number of key contextual issues pertaining to the case. I have argued that a strong and rich organisational heritage has formed the foundations of a company that has over time developed a cultural significance beyond its economic value. Established traditions, supported by key figures, provided stability and continuity for much of the organisation's history. However, this organisational heritage also created a legacy of inertia and an internal resistance to change that hindered developments in the company's more recent history. As a consequence, strategic realignment and change has suffered in the face of capability imbalances precipitated in part, by the departure from existing practices.

Crucial to the challenges faced by the company has been the turbulence of the market environment and the changing contextual elements of the company's operating environment. Significantly, a key component of these changes has been the evolution of existing, and the emergence of new, increasingly complex, environmental pressures. For ECC, these changes have been exemplified by a need to examine and redefine relationships with key stakeholders that include, paper customers, employees, the local community, the regulator and the Mineral Planning Authority.

Chapter Six: Environmental Capability Explored: Pollution Prevention

6.1 Introduction

This chapter explores the first set of propositions developed in chapter three that aim to empirically investigate selected resource characteristics which have been conceptualised as underlying a pollution prevention capability (see Figure 6.1).

Resource Characteristics: Pollution Prevention
1a. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of Total Quality Management.
1b. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of 'green teams'.
1c. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of employee involvement.
1d. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of environmental awareness.
1e. A firm will be more likely to develop a pollution prevention capability when it can demonstrate the resource characteristic of environmental values.

Figure 6.1: Research Propositions: Pollution Prevention Capability

In order to do this, I present empirical evidence that makes use of the full range of data sources described and discussed in chapter four.[1] This means that key emergent themes may be supported by either qualitative or quantitative data, or a combination of these, and as such findings are presented concurrently. As indicated in chapter four (section 4.3.2), data collection for these propositions used an 'embedded' case design and was framed by the organisation's Environmental Management Programme (EMP). The EMP may be characterised by a series of policies and activities, and focuses specifically (as

[1] Reference to empirical data sources are made using the following notes and symbols:

- interview transcripts – Transcript #;
- field notes – *fn (date);*
- quantitative questionnaire data – Q (question number);
- qualitative questionnaire data – *qn (questionnaire number).*

outlined in chapter five) on the company's operational work at its Cornish production base.[2]

The chapter is broken down into seven sections. In the first section I provide an overview and analysis of the company's EMP to date. This serves to indicate the 'state of play' and official company strategic direction during the study period. In the following five sections I deal in turn, with the resource characteristics identified in chapter three. Each section is preceded by background contextual details that serve to assist the subsequent analysis. Possible indicators for the presence, absence and relative strengths of these characteristics, and therefore their potential contribution to the key resources and capabilities under investigation, are discussed through emergent themes. In section 6.8 I summarise the key issues discussed in the chapter and suggest outstanding themes to be discussed further in chapter nine.

6.2 Environmental Management Programme

6.2.1 Background

In the early 1990s ECC's organisational response to environmental concerns reflected both the level of priority as perceived by the organisation at that time, and the functional nature of the organisation's structure (Handy, 1993). This structure, which was both originally designed and had subsequently evolved to perform the task of mineral production, did not appear to address environmental concerns in any systematic way. In the years immediately preceding the study period, no organisational functional unit dealt specifically with environmental concerns as their core task. As a consequence, environmental responsibilities were not officially designated beyond those individuals who intrinsically (even if it was not formally recognised as being so) undertook environmentally-related tasks as part of their jobs (for example, the company's landscaping efforts and work in the energy management section).

However, as interest in, and concern for, environmental issues started to grow, the co-ordination of information and the provision of advice internally, fell to the Technical

[2] Some comparative data from the company's US operations is also presented where appropriate.

Services division of the company (*fn 27.2.97*).[3] In particular, senior staff in this area found themselves responding both to technical queries from customers (relating to areas such as life-cycle data) and concerns from individual members of the local community adjacent to the production sites (*fn 28.2.97*).

With concern for the management of environmental issues growing, particularly in the face of emerging new legislation such as the Environmental Protection Act 1990, the company made its first formal moves towards environmental management. In 1992 consultants were commissioned to undertake a brief environmental review of ECC's pits and works in Cornwall. The results of this survey were used to produce a series of checklists and a methodology designed to allow the company to carry out its own environmental reviews. More specifically, it aimed to provide the foundations for work that would aid the company in 'satisfying legislative requirements and monitoring environmental performance' (Haliburton, 1992). The survey techniques were 'piloted' at one drying site that acted as a training exercise for the staff involved.[4]

Retrospective reviews of this consultancy through conversations with managers in the field brought a mixed response. Most had little recollection of the exercise, although those who did recall the work felt that it had not been sufficiently and systematically pursued following the initial input, to be of any long-term value. Only those who had been most closely involved at site level felt that it had been a valuable exercise and had subsequently endeavoured to undertake the tasks highlighted by the review in their production locations (*fn 4.2.99*). These comments largely support the lack of evidence (absence of company review documents and data) that the work undertaken at this time was developed in more detail beyond the original pilot site.

During this period the company also published its first environmental policy, which included both a statement of the Group intent and a series of guidelines to manage the environmental impacts associated with operational activities. The policy made some key commitments which included, a recognition of environmental concerns, a commitment to continuous improvement, board level responsibility including the allocation of

[3] Technical Services traditionally operated in a support role addressing concerns in the production environment and in the technical development of products.

[4] The part of the operations, described in chapter five, where clay is dried, prior to bagging and transportation.

resources as necessary, and a commitment to report progress annually to shareholders (ECC, 1992a). However, the tenet of the document is one of caution, with emphasis placed on the notion that the economic value of mineral production is such that there are likely to be acceptable levels of environmental harm. Additionally, commitments to improvements were bounded to minimum levels as they related to statutory and legislative requirements. This suggests a reluctance to work on improvements beyond compliance and more significantly, implies that the appearance of environmental activity could be maintained with little change in practice at operational level.

Nevertheless, by the mid 1990s, these tentative steps towards a methodical system of environmental management were beginning to be pursued more systematically on the ground. This included moves to formalise existing 'good housekeeping' procedures and to provide control systems for environmental impacts (*fn 4.12.96*). In 1996 the changes brought by company reorganisations and redundancies saw responsibility for environmental work pass to the Mineral Resources function of the company (involved in a number of activities including the survey and engineering of site works and mineral waste tips). This move resulted in a small number of staff being grouped into an 'Environment Section' with 'officers' taking specific responsibility for managing the impacts to air and water of the company's operations. One member of staff began to oversee the development of a more coherent response to environmental issues by revisiting the work undertaken in the 1992 Environmental Review. Specifically, this staff member worked to scope the issues (as outlined in the review methodology) at a pilot site in order to determine the extent and nature of information that would be required for the company to work towards a more formal (certified) environmental management system across all the production sites (*fn 28.2.97*).

In spite of this clear sense of need at middle management level, there was no conspicuous, formal, board level commitment to develop a certified environmental management system at this time. As a result the resources dedicated to staffing environmental work were limited, frustrating progress on the ground. While a senior manager took on responsibilities for environmental work as an addition to existing tasks, this transitional period is notable for the lack of any clear direction, resourcing or progress with environmental work.

6.2.2 Contemporary Developments

The most significant step forward came in 1997 when, following signals from several key customers and internally, the company embarked on a strategic review of its 'position' with regard to environment, safety and health *(fn 16.6.99)*. To facilitate an understanding of the issues the company commissioned a leading environmental consultancy to conduct a review in four areas:

- policies, goals, requirements and guidelines;
- key responsibilities accountabilities and resources;
- assurance mechanisms and;
- reporting mechanisms.

The review also considered the company's environmental position in relation to its customers and competitors. While the use of consultancy for this type of project could be regarded as standard practice for a modern organisation of this size, it does reflect the extent to which knowledge in relation to environmental issues was lacking, particularly at a senior level.

This dearth of strategic attention to environmental issues was reflected in the report, which drew notice to some serious deficiencies in the way the company was managing its environmental responsibilities. As noted above, the review stressed that to date, there was no co-ordinated approach in place to manage environmental issues and that accountability for environmental work was unclear. With limited use of quantifiable environmental targets, the ability of the company to report relevant and accurate environmental progress was considered to be curtailed. Perhaps most significantly though for the company's standing, was benchmark data which suggested that when assessed against the (now established) Business in the Environment (BiE) index of corporate environmental engagement, the company was performing significantly below the sector average (BiE, 1997). Reflections with the company's environmental staff on these findings indicated that while this information was for them not unexpected, it served to stir some of the more sceptical senior managers *(fn 1.2.99)*. Importantly, the report findings led senior directors to state explicitly at an internal global management forum that, managing environmental, safety and health issues more effectively could be good for the business.

Armed with the information that environmental management was now a business concern, the company considered a series of possible environmental 'positions', illustrated in Figure 6.2.

Compliance	Performance Improvement	World Leader
• *commit to comply with regulations* • *no commitments to external schemes or charters* • *no public reporting* • *qualitative targets* • *corporate 'guidelines' for business* • *no formal EMS*	• *ISO 14001 at selected sites, some certified where possible competitive advantages exist* • *use of meaningful benchmarks within sector* • *quantitative targets* • *published ESH report* • *commitment to compliance and/ or higher where possible/ economic* • *formal/ appropriate EMS for all business*	• *ISO 14001 certified at all sites* • *top 10 benchmark in sector* • *leader in standards* • *ambitious quantitative targets* • *social and community programmes* • *beyond compliance in all areas*

Figure 6.2: Environmental Positioning (adapted from ECC, 1998).

When considered in the light of discussions on the 'models of corporate greening' (chapter two, section 2.13.2) these positionings appear to reflect both environmental risk and market opportunity, as well as internal perspectives of organisational constraints (Hunt and Auster, 1990). As I noted previously, there is a heuristic value in this modelling approach and at the time of this review, the company were, according to their own categorisations, placed firmly in the compliance position. The decision therefore to work towards a 'performance improvement' position represented a substantial shift in commitment for the organisation as a whole and was arguably the first formal recognition at a senior level of the wider threats and opportunities associated with working towards environmental improvements.

In line with this decision a new framework of accountability emerged. At plc level a director with responsibility for the new Global Environment Safety and Health (GESH) programme was appointed. Nominated senior personnel were given regional responsibility for various aspects of the programme, reporting back through a GESH Team to board level. Within this regional remit, personnel were provided with scope to develop systems and procedures appropriate to their operations while embracing eight key elements, illustrated in Figure 6.3.

Key Components of ECC's ESH Programme
• *objectives and targets*
• *responsibilities and accountabilities*
• *management programmes/ action plans*
• *training*
• *ESH procedures*
• *inventories/ documentation*
• *auditing/ inspection*
• *performance/ reporting*

Figure 6.3: ESH Programme Components (adapted from ECC, 1998).

The configuration of responsibility for the European and Cornish operations included the establishment of a 'leadership team', as well as a series of sub-teams to execute the programme (Transcript # 12). This new organisational structure for the 'environment' part of the programme is shown below in Figure 6.4.

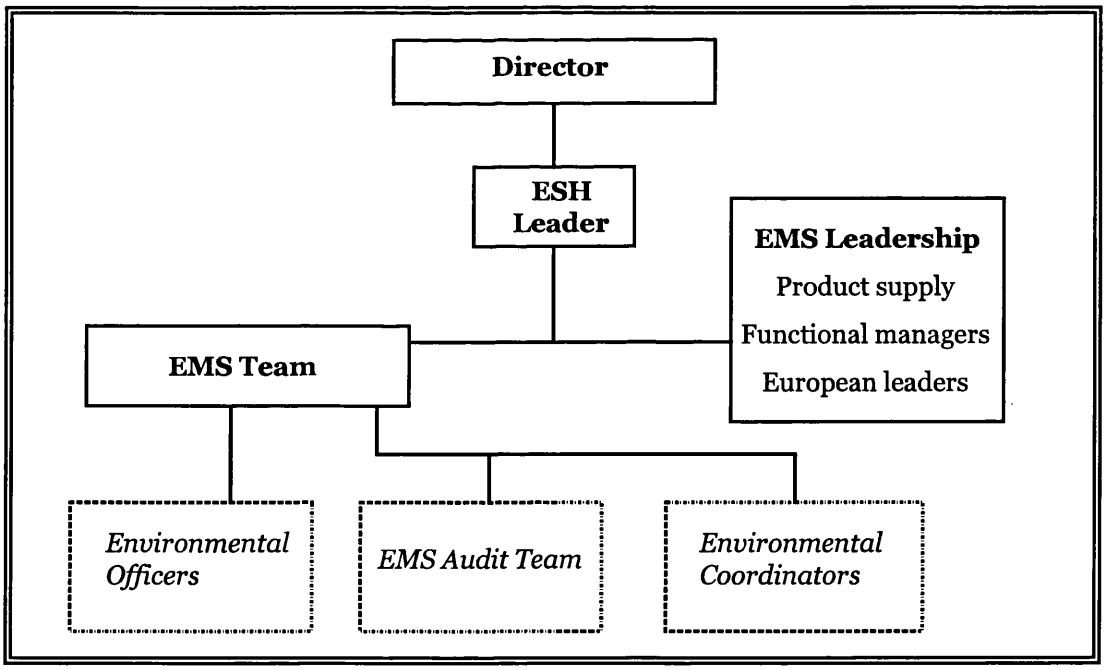

Figure 6.4: ESH Environment Organisation (adapted from ECC, 1998).

The results of the review were, therefore, to place environmental work on a more formal footing, with commitment to develop environmental management systems and auditing procedures, and to make responsibility and accountability for environmental work more explicit.

During the study, senior personnel appeared to make a number of efforts to stress the strategic view that this new phase of environmental work should not be considered a 'badge collecting' exercise. In other words, work was to be focused on continuous improvement goals rather than on achieving certification to an environmental standard (*fn 23.7.98*). This emphasis reflected experiences with previous initiatives where it had been perceived that the standard, rather than the process of achieving the standard, had been the key aim (Transcript # 7). Nevertheless, there was a pervasive view amongst middle management working on environmental issues that for senior personnel, it was primarily certification that would relieve some of the external environmental pressures the company was experiencing (*fn 16.7.98*). This mismatch of expectations was a recurring theme throughout the study, and while interesting to observe, is not considered in great detail in this thesis. Differing expectations have however, formed the crux of some debates in environmental management that have assessed the long term cultural and strategic changes required for organisations engaging in environmental management activity (Halme, 1997).

With an ambitious timeline and interim objectives established by the review procedure, it became increasingly apparent that implementation would be beyond the scope and resources of the existing EMS team. Additional consultancy input was therefore commissioned to develop and train the audit team, necessary for an audit programme. Further outside support was also sought through a training provider to achieve the coverage of training suggested in the review. Team development and training are discussed further in sections 6.4 and 6.6 respectively.

This new position, in terms of organisational structure and staffing, which emerged in the first year of the study remained substantially unchanged for the duration of the project. However, the issues and concerns generated by this new commitment to a more

focused and proactive approach to environmental management, frame much of the subsequent analysis in the chapter.

6.2.3 Summary

In this section I have outlined how the management of environmental issues at ECC evolved in the period prior to and during the study. Initially environmental concerns were dealt with in an *ad hoc*, informal way. Responsibility for environmental work was 'acquired' rather than designated and although middle managers had begun to recognise the importance of a more focused approach to environmental management, there was little impetus at a strategic level for change.

This situation changed markedly following the 1997 review, when the company made a strategic commitment throughout its global operations to engage more proactively with the environmental management agenda. This meant that for the first time environmental responsibilities and accountabilities were assigned to senior personnel, and in the UK this led to the launch of a programme of activities to address the deficiencies highlighted by the report.

6.3 Total Quality Management

6.3.1 Background

Analysis of contextual data and background company documents at ECC suggested that conceptions of quality have become closely associated with the clay product itself. Until the recent discovery of high quality clays in South America, Cornish clays were widely acknowledged to be geologically superior across a range of criteria and therefore highly sought after in the market (Murray, 1984). Confidence in the quality of product was bolstered by a research department capable of developing new products for the paper industry (as discussed in chapter five, section, 5.2.1).

This combination of unique mineral properties and research and engineering expertise has allowed ECC to consistently market clay products on the basis of superior quality. As a result, commitments to quality run throughout company literature. In particular, ECC has adopted quality as one of the key criteria on which the company seeks to differentiate itself from competitors (ECC plc, 1998). This concern for product quality

has been heightened internally by the publication and dissemination of the 'Mission, Values and Working Principles' document which stresses a commitment to product quality as part of the company's mission statement.

The result is that quality is arguably a recognisable and key element of organisational culture at the company, with employees expressing a discernible pride that the products they produce are world class. This apparent quality ethos is however, implicitly product focused. This assertion is well supported by findings from the project questionnaire, which showed that personal and perceived corporate values are highly congruent in relation to product quality.

Questions 5 and 7 of the questionnaire asked respondents to rank product quality from a personal and perceived corporate perspective in relation to four other factors (creativity, environment, profit and people). The questions used a ranking scale where 1= most important and 5= least important. The creation of a composite measure (where, the difference between the two value sets equals perceived corporate values minus personal values, explained further in section 6.7) allowed a comparison of these values across the sample. The results of this test produce a mean value close to zero (see Figure 6.5). This, together with low skewness and kurtosis (also close to zero) indicates little significant difference between the two data sets.[5] This expression of shared values lends weight to the suggestion that product quality is a discernible facet of organisational culture in the company.

Statistic	Mean	Standard Deviation	Skewness	Kurtosis
Product Quality	0.17	1.13	0.12	0.37

Figure 6.5: Descriptive Statistics for Composite Measure of Personal and Perceived Corporate Values: Product Quality, (n= 397).

This focus on quality is, however, less evident in relation to the production processes that deliver the clay product, where quality appears to be a rather 'static' concept that is controlled by the quality system (ECC, 1995). Quality, as it is conceived in this

document, is about, identifying defects, taking corrective action, ensuring that designated standards are met and implementing improvements where necessary (ECC, 1995, p.5). As such it displays a 'command and control' focus characteristic of the ISO 9000 quality standard (Seddon, 1997). The system therefore lacks the fluidity and more challenging targets that authors argue are essential for moves toward Total Quality Management (Heilpern and Limpert, 1991). Specifically, while the system makes reference to the needs of customers, its focus and definition of quality is largely internal. This contrasts with the TQM view, which sees the management of any process as being driven by the potential needs and requirements of external customers (DeSimone and Popoff, 1997). The company's approach to quality has, to date, been bounded by a static conception of quality. This is illustrated by two key themes, which emerged during the study. These issues are discussed in turn below.

6.3.2 Document Driven

Several interviewees intimated that the quality system had never been a popular initiative with those required to undertake the implementation (*fn, 19.4.97*). In particular, the use of a consultancy to help design and implement the system was seen by many to have bypassed the inherent, tacit knowledge of those staff involved in quality work. For these interviewees, their relative lack of involvement with the system development meant that they felt little sense of ownership. Several respondents referred to the system as a 'consultancy implant' and extended this metaphor to suggest that as a result, the system had never really been embraced by those undertaking the day-to-day activities that ensure the smooth running of the system. One of the key issues that prevented managers moving beyond the more static concept of 'product quality' was the sheer burden of documentation associated with keeping the quality system up-to-date. As was commented:

> "One of the big problems with having a system is maintaining all the paperwork, because [the] system really is just formalising what we do already." Transcript # 10

This echoes a key argument made by Seddon (1997) that quality systems have the tendency to generate additional bureaucracy that stifles, rather than encourages, improvement. The documentation burden was also commented upon by one manager,

[5] Levels of significance are calculated using one-way ANOVA. For a discussion of statistical test choice see chapter four, section 4.8.2).

who, had been considering the extent to which the quality and environmental procedures could be integrated. His rationale was based on the premise that to combine the two would reduce the level of paperwork dealt with by managers. However, his investigations concluded that:

> "... to include them all [environmental procedures] in the [quality] system would have taken too long; it was just too much work..." Transcript #1

This manager also noted that maintaining the existing documentation for the quality system was extremely difficult as changes to process routes and chemical usage (necessary in the processing of clay, see chapter five section, 5.6.1) meant that procedures were continually becoming obsolete. Nevertheless the requirement to maintain the system meant that managers were largely occupied by updating the paperwork (necessary to keep the quality standard) rather than looking for more innovative approaches to improving the quality of the system *per se*.

The growth of the bureaucratic burden had become an increasing problem as management reorganisations reduced the number of employees available to 'attend' the quality systems. These 'human resource' shortages emerged as a second key theme from the data.

6.3.3 Human Resource Shortages

Total Quality texts frequently expound the virtues of cascading responsibilities for quality down the system to involve workers at all levels (James, 1996). Quality, it is argued, then becomes embodied in the individual and it is the collective tacit knowledge of these workers that ensures quality moves beyond the more static confines of the documented system. However, this use and promotion of an 'in process' quality ethos relies, to some extent, on the degree of slack in the system, where slack is viewed as the resources available for innovation and change (Cyert and March, 1963).[6] Workers operating in a stretched capacity are unlikely to move beyond the tasks necessary to maintain a baseline level of performance. Key therefore is the availability of workers to 'staff' the system. At ECC the periods of restructuring and de-manning, were having a profound impact on the ability of workers to assure quality. Typical comments included:

[6] See Bowen (2000b) for a detailed discussion on the role of slack in the implementation of environmental initiatives.

> "We have reduced manpower to very low levels and in some cases we barely have enough for people to keep the system going; the lads out there [in the operations] are struggling." Transcript # 1

> "The same managers and captains have got far more things to do now than they ever had before. They are much more thinly spread." Transcript #10

Additionally the de-layering and progressive reduction of middle management positions, meant that any intentions that may have existed towards building a more deep seated basis for quality, were lost. As two managers both noted:

> "We have lost a lot of experience over the last few years, so by the time you would really like to be building on what you have got there are other [competing] interests taking people's priorities." Transcript # 3

> "Everything is stretched, that is how I would best describe it ... and I think that quality has suffered [as a result]." Transcript # 1

In this case the evidence presented points to a number of observations. First I would argue that the system itself, while an accepted cost of doing business in this context, has acted as a brake on a 'freer' management approach, characteristic of TQM. It is suggested that workers and managers have found themselves constrained by procedures. Additionally the foundations of the quality system have been undermined by ongoing periods of organisational change. As a result any dynamism that may have been derived from using existing collective tacit knowledge in a new approach to quality, has been forsaken, both within the system itself and strategically. As one manager acknowledged:

> "It was admitted [by senior personnel] that we were only really doing enough for the quality system to keep the badge, we never really had a mission to go beyond that and develop TQM." Transcript #1

These comments suggest that an identified gap exists between, company rhetoric on quality, and the organisation's ability to deliver. While the value of quality is espoused, the reality of maintaining and progressing quality ideals is hampered by key constraints. These constraints, which reflect in part the prolonged period of organisational turbulence at ECC, have restricted the pursuit of quality ideals as they are conceptualised by authors in theoretical work on the development of environmental capability (Hart, 1995).

6.3.4 Summary

This section has argued that the concept of quality at ECC revolves around an end product rather than as an intrinsic part of the production process itself. Progression beyond this more static conception of quality has been hampered by the bureaucratic burden of achieving and maintaining the ISO 9000 quality standard, and is further exacerbated by the ongoing reduction in the number of relevant personnel.

As a result, the organisation appears to lack both the capacity and the strategic aspiration to pursue the more challenging goals that authors associate with TQM (James, 1996). With personnel still absorbing the new management approaches brought by reorganisations, there is little evidence of TQM practice. This may be acting to limit the development of a pollution prevention capability.

6.4 Green Teams

6.4.1 Background

During the study period ECC could be regarded as essentially structured along functional lines (as defined, for example, by Handy, 1993). Although the emergence of business units and moves to de-layer existing middle management removed some of the hierarchies and functional separation, much of the traditional bureaucratic structure remains in place.

For instance, the notion of team working, and more specifically, the use of teams to drive forward change was observed to be a relatively new phenomenon in the company. Team working was brought in as part of the wave of internal management initiatives underway during the study. Introduced through the Continuous Performance Improvement (CPI) initiative (discussed in more detail in chapter 8, section 8.2) teams were, for the first time, being used to bring together complementary skills from across the functions. Under the strap line 'together everyone achieves more', teams were specifically being targeted to deliver a series of ambitious cost reductions for the organisation across a range of issues.

The launch of the ESH initiative with its concomitant objectives and targets saw the work requirements for existing environmental staff, rise significantly. However, the

strategic commitment to improve environmental management also witnessed the expansion of the human resource applied to environment related tasks. In particular, the study identified teams emerging at two distinct levels. First, at a strategic level a number of teams were developed to both steer and deliver key facets of the environmental management programme. Second, a more organic process appeared to be surfacing that consisted of ephemeral teams dealing with site specific issues as they arose, out in the clay operations. These two areas are discussed in more detail in the subsequent sections.

6.4.2 Strategic 'green teams'

In line with the company's more progressive moves towards a task-oriented business approach with team structures, environmental interests started to be represented at a strategic level. This new approach involved the establishment of a Global Environment, Safety and Health *strategy table.* This 'table' was described by the company, as a long term, strategic addition to team working which would examine issues affecting the management and strategy of the company in this context (ECC, 1999). Chaired by the Chief Executive this 'table' would mostly be involved in strategic decision making for the group as a whole. A greater application of team working was implied through this device which brought together those managers closest to the application of ESH strategy on the ground. Interviews with senior managers from both the European and American sections of the company suggested that this was the context in which:

> " ... we meet on a regular basis and actually talk about and discuss the actual initiatives that we are going to try and follow... and we exchange experiences." Transcript # 12

However, when pressed on this issue it was conceded that while experiences were shared, little actual exchange of documents and examples of best practice took place. In fact, both managers indicated that while the strategic level 'table' created a framework for action, they continued to work relatively autonomously at different operations. One manager further expressed some misgivings about the directions chosen by the 'tables'. He suggested that smaller, organic team initiatives appropriate to site level issues and experiences were a better approach to environmental management than the wholesale embracing of 'global standards' (Transcript # 5).

In recognition of the need to devolve responsibility and create a more inclusive style of environmental management, managers responsible for the company operations in Cornwall and Devon, formed the Environmental Management System (EMS) team. Until this point, much of the practical work associated with all aspects of setting up a management system had fallen to the company's environmental scientist. The role of this team was (with consultancy support) to put in place the key building blocks of an environmental management system that would form the foundation of the company's environmental management programme. The team comprised the senior manager responsible for delivering the 'environment' part of the ESH initiative, the company's environmental scientist, a senior surveyor seconded from the mineral resources function and latterly (in 1999) a second surveyor seconded from the ball clays division. This choice of personnel drew mainly from the mineral resource function, with no discernible attempt to extract expertise from other functions. Although, as one manager suggested:

> "... the role of mineral resources is so closely linked with environmental concerns that it implicitly acts as an 'environmental department'." Transcript # 19

Observations of the team at work highlighted a number of issues. Although conceived as a 'team', the senior manager continued to adopt a clear leadership role in this context, rather than opting for a more equal share of responsibility. Much of the work undertaken (for example, developing an audit schedule) involved individual effort and hence implied individual accountability. Rather than working collectively, the nature of the tasks involved and the time available to team members, meant that team meetings tended to serve as 'report back and planning sessions' as opposed to a forum where issues were discussed and resolved collectively. In essence therefore, the team performed more as a 'working group', than a team as defined by Katzenback and Smith (1993) (see chapter three, section 3.3.2).

For example, at an observed meeting, (*fn 12.2.99*) the team covered a range of issues relating to:

- environmental objectives and targets for key personnel;
- dealing with company tenants (as a large land owner in the area the company is responsible for a number of tenant-occupied properties);
- writing environmental procedures;

- the impacts of recent environmental incidents (pipeline burst and a non-compliant discharge);
- the forward programme for auditing.

Although the group discussed these issues as they arose, the tenet of these meetings was generally one of efficiency, frequently achieved through delegation of tasks to the individual members, without time spent actively problem-solving in a group context. In addition the team was constrained by the time availability of its members. During the study period, only one member of the team could be considered as engaged with environmental issues full-time. The remaining members, including the senior manager, operated on a part-time 'secondee' basis that required them to juggle their workload with other organisational responsibilities and deadlines.

This analysis reinforces the suggestion that, according to conceptual criteria, the EMS team did not operate as a team, but rather as a working group. Nevertheless, the positive effects of establishing this small but critical mass of people working towards some commonly agreed goals were clear. During the periods spent observing the EMS team, progress was made, for example, towards developing and refining a set of procedures necessary for the formal environmental management system. Delivering these procedures in a manner appropriate for the clay operations required the joint expertise of the team and represented a critical part of establishing the system foundations. However the limitations of the team indicated above, also meant that when a key member was lost to an 'alternative company project' the ability of the remaining members to deliver according to a defined project timeline was severely curtailed (Transcript # 19).

A second key team to be established during the study period, was the *audit team*, as illustrated in Figure 6.4. This team was considered crucial to the successful implementation of the company's EMS. Significantly this team included a range of personnel with expertise in site level operations, environment, engineering and surveying. The members were selected, by the EMS team, for their job specific experience and personal competencies. Once chosen, the team was envisaged as taking

a lead role in the company's bid to audit the entire operations in preparation for the implementation of the EMS.[7]

While highly competent in their respective areas, each potential auditor was largely new to the issues and challenges associated with environmental auditing. Consequently this group underwent an intensive five-day training course delivered by the consultancy contracted to provide ongoing support to the EMS team. The decision to train existing staff as part-time auditors, rather than employ full-time dedicated personnel, was officially justified on the basis that dedicated audit staff could appear divorced from the operations and running of the business (*fn 28.7.98*). However informal discussion on this subject suggested that this choice was more closely associated with resourcing issues in the organisation as a whole (*fn 23.7.98*).[8] Once trained, auditors would work in smaller groups, under the direction of the EMS team, auditing the areas of the operations where they had most expertise. Again while it was originally conceived that they would operate as a team, the trained auditors operated as a loosely co-ordinated working group.

Both the EMS and audit team emerged as a direct result of the company's more strategic approach to environmental management issues. While it was too early to judge their effectiveness at the end of the study period, comparisons to progress made prior to the ESH initiative suggested that the teams had achieved the critical mass necessary to move forward the building blocks of a company-wide EMS.

In this context the teams had fulfilled many of the criteria that authors argue are necessary to propel environmental change through organisations (see for example, Moxen and Strachan, 1998) in particular, initiating a process to overcome cultural and structural inertia. The evidence for this could be seen in a new, widespread enthusiasm

[7] An environmental audit is defined as, "A management tool comprising a systematic, documented, periodic and objective evaluation of the performance of the organisation, management system and processes designed to protect the environment. With the aim of: 1) facilitating management control of practices which have an impact on the environment; 2) assessing compliance with company environmental policies." (ICC, 1991)

[8] This is interesting, as a conservative estimate of the time requirement for each auditor (from a final total of 24 trainees) was 3 weeks per year.

from employees to volunteer for company environmental co-ordinator positions, that would act to cascade down environmental responsibility (fn 19.1.99).

Although conceived as teams, the evidence suggested that both the audit and the EMS team worked largely as directed work groups, retaining leadership roles and carrying out tasks on an individual basis. Significantly though, in the periods of study and observation both teams appeared to be effective in progressing the environmental agenda in the organisation and increasing the skills base appropriate for environmental management tasks.

6.4.3 Ad hoc/ informal teams

An interesting phenomenon to emerge during the study was the development and use of small, *ad hoc* and informal teams at site level to deal with environmental concerns. At ECC, managers have historically possessed a large degree of autonomy when working at operational level. This relates in part to the legal responsibilities associated with mines and quarry legislation that managers are required to uphold. One feature of this style of working is the relative freedom of managers to apply their operational staff to a range of tasks as necessary. During the interview phase, it became clear that a number of managers were creating ephemeral teams to respond to environmental needs as they perceived them. Some managers assembled teams in response to a particular trigger, for example:

> "I decided to get a team together [on the basis of a public complaint relating to dust], a small number of people who've got knowledge of the equipment as well as the knowledge here on site that we need." Transcript # 17

As another manager commented in response to a discussion about an effluent discharge problem:

> " ... that is a team I set up because sometimes when it [the effluent discharge problem] is really bad it gets to the point where we have to shut down one of the plants. Now obviously that costs a lot of money and we want to deal with the problem at root cause." Transcript # 2

That teams could be useful for particular issues appeared to have been learned from manager's personal experiences of participation in the CPI initiative. Several managers referred to the momentum and rapidity of change that they had encountered while working in CPI teams. The result was arguably a more rapid than expected 'trickle

down' effect of internal organisational change, with managers using the skills they had acquired in their immediate work context. In each case, managers were keen to emphasise how these teams really were most effective as they devolved responsibility and initiative back to site level, as evidenced by the comment:

> "We are now setting up small, localised energy teams to look at their sites. It is the man on the site who knows whether things are being done or not, so we are putting it back to site level." Transcript # 19

The experiences of these managers suggested that small teams and team working were being proven as an efficient way to tackle environmental concerns on their sites. In fact, several managers commented informally that while team working was now more popular and 'fashionable' in the upper echelons of the organisation, it has always been their reality that small teams were a useful improvement mechanism. This general enthusiasm did not prevent a number of respondents sounding a note of caution with regard to teams, which was reflected by a staff member who noted that:

> "... first of all there was a team set up. But it just 'disappeared' into me doing it, [work on a waste and packaging programme] because unless somebody runs with it, it just doesn't happen does it?" Transcript # 3

Therefore, although a large proportion of the evidence pointed towards the successful use of teams, some members of the organisation were harbouring negative experiences as a result of poor organisation, which had not been recognised or resolved by their line management.

6.4.4 Summary

The evidence outlined above, suggests that 'green teams' were present in the organisation at two levels. Strategic teams and their more practical counterparts (the EMS and audit team) were instigated largely as a result of the ESH initiative. Although the practices of these teams did not adhere to the conception of teams offered by authors (Weiss, 1996) they appeared to be effective at extending and informing other members of the organisation about environmental practice (Ayers and Green, 1996).

The data also revealed that managers used ephemeral teams to tackle environmental issues at site level, by drawing on existing expertise. Interestingly these experiences in the UK were also reflected in the US operations where, managers described the use of site level 'natural workgroups' to solve short-term environmental problems (Transcript

5). Cumulatively the evidence pointed to the growing and effective role that teams were playing in progressing environmental management objectives.

6.5 Employee Involvement

6.5.1 Background

In the case context chapter five (section, 5.3.1) I described how organisational restructuring in the early 1990s brought significant reductions to the Cornish workforce. While there was inevitably some de-layering of middle management, a large proportion of the redundancies and early retirements occurred at operational level. In building an understanding of this case, I became strongly aware of the core conception in the company that it is on site, at operational level, that the 'real' work of this organisation is done. In previous decades most senior staff in the organisation would have been required to have progressed up through the ranks, 'serving their time' as a manager on one of the operational sites. More recent company history showed these 'rites of passage' changing with the appointment of new senior staff to the organisation who did not necessarily have direct industry experience. Conversations with operatives on site suggested that workers felt increasingly divorced from the senior managers, whom they rarely saw. As one operative remarked:

> "... senior managers are no longer prepared to get their boots dirty..." (fn 20.7.98).

This perceived distance of senior staff and the net loss of workers on site through progressive 'trimming', had perceptibly impacted worker morale (*fn 23.7.97*). In particular, there was a pervasive sense that the company no longer valued the workers responsible for the core production from the Cornish 'cash cow'. Several workers reflected their disillusionment by commenting that:

> "It's not the same company we used to work for..." (fn 20.7.98)

A key facet of the organisational change underway during the study, was the company decision to embrace Investors in People (IIP) as one of number of mechanisms, (including improved communication) to rejuvenate and invest in its demoralised workforce. Specifically, it was recognised that in spite of an historically buoyant training

regime, ongoing training and development had lapsed (*fn 29.5.98*). This decision to adopt a more participative approach to training and work towards IIP, was made at a strategic level and was one of only two strategic company targets for the period to 2000, (the other target being to increase profit margins).

Time spent on operational sites during the study, allowed operatives to reflect on the instigation of IIP. A number of operatives I spoke to felt that the IIP initiative was just another one of a series of initiatives that exemplified the difference between company rhetoric and the reality as they experienced it (*fn 20.7.98*). A more senior shift captain, who by the nature of his job would be more involved with actually conducting training, expressed the opinion that IIP was just an additional distraction in his already time constrained day.

> "It [IIP] is basically composed of things like NVQ training that we have always done. They [senior management] keep coming up with areas and saying that it will be a part of IPP but it is nothing new." (*fn 24.7.98*).[9]

These perspectives suggest that while the company was embarking on a more inclusive approach to training and development, significant impetus was needed to capture the more jaded and sceptical elements of the workforce. The measure of the task ahead for environmental work, and more generally for the new training regime, was reflected in the data delivered by the project questionnaire.

The above qualitative findings concerning training, sharing of best practice and employee involvement were then explored further through the questionnaire. Question eight of the project questionnaire included nine value statements with which employees could agree or disagree on the basis of a 5 point Likert Scale, (where 1 = strongly agree and 5 = strongly disagree). Analysis of the nine value statements showed that three of the nine statements yielded on average significantly more neutral responses (higher than 3 on the Likert scale) when compared with the other statements which were consistently positive (see Figure 6.17 for all nine statements and their overall means). This trend was supported following an analysis of variation using one-way ANOVA across company hierarchy and functions, and is discussed in more detail in section

[9] NVQ, National Vocational Qualifications.

6.7.4. The three value statements yielding consistently more neutral responses all related to aspects of employee involvement, and are reproduced in Figure 6.6.

Question 8:	Statement	Overall Mean	Standard Deviation
f	ECCI involves employees at all levels in the development of environmental projects.	3.56	0.89
g	At ECCI, departments share environmental best practice.	3.31	0.89
b	At ECCI, employees help in the design of environmental training programmes.	3.30	0.90

Figure 6.6: Values Statements Yielding Neutral Responses (n=415).

These finding suggest that at the time of the study employees did not feel involved in environmental change. Analysis of interviewee responses to issues concerning employee involvement reflected these difficulties as well as the more progressive policies being initiated by the company at this time. These issues are discussed further in the following sections.

6.5.2 Delegation

I have discussed previously (chapter three, section 3.3.3) how authors have been keen to cite the advantages of employee involvement in achieving environmental improvements. However in doing so, they rarely reflect on how organisational context can impact attempts at involvement. I have argued that at ECC, the legacy of past work practices and turbulence brought by recent organisational changes have the potential to impact the newer, less established environmental initiatives. Discussion with interviewees suggested that employee involvement in environmental initiatives was primarily a necessity brought about by new ways of working and ongoing resource depletion. Although involvement could also be considered the most favourable option, most managers identified the limited choices they possessed in making these decisions.

> "We've got different priorities now, [including environmental work] so we push things down through the system. There are fewer chiefs and more indians and the indians are sub-chief if you like, taking responsibility for their own little area instead of just coming to work, doing their job and going home." Transcript # 15

Interesting here, is both the language used and the perspective conveyed by this particular manager. Subsequent discussion suggested that he was not entirely comfortable with this way of working. While he saw the devolving of responsibility as necessary, he recognised that some workers were not adequately equipped (in terms of skills and knowledge) or inclined to shoulder additional responsibility in their jobs. These concerns reflected the ultimate responsibilities held by all mines managers. His reluctance was shared by colleagues, one of whom said that:

> " ... we are sharing out the work ... the only way to do this is to pass it down and out so that more and more people are involved." Transcript # 11

It is important, therefore, to observe that while employee involvement appears to be universally cited as desirable, in this context of managerial and legal responsibility involvement was driven more by necessity than choice.

6.5.3 Developmental

Most interviewees recognised these difficulties when trying to involve employees at all levels. However, a significant number of interviewees saw involving employees in environmental work as a new avenue for career improvement opportunities. A member of the EMS team was clear in this objective stating that:

> "It is a developmental thing. We wanted the environmental co-ordinator and certainly the auditor role to be seen as a developmental role for people and that is how we approached managers when we asked for names." Transcript # 18

This attempt to involve people could contribute towards a more engaged workforce. As one of the operations managers stated:

> "It [the environmental management training work] has made people feel that they are more worthwhile and that has probably been a good morale boost." Transcript # 11

These sentiments were reinforced by a further respondent who had begun to observe the effects of involving employees more thoroughly in the mechanics of getting the environmental management system off the ground:

> "A fair number of people feel that they are making a difference now, whereas perhaps they were not making a difference before ... an awful lot of the time people [in operations] do the same job day in and day out and they don't get to see the results of it." Transcript # 7

Key here, was the identification that involvement with environmental work, particularly at site level was frequently rewarded by immediate tangible results. For example, an EMS team initiative on fly tipping (the illegal dumping of domestic and industrial waste) saw reported incidents rise, as employees worked to maintain the visual and environmental integrity of their sites (ECC, 1998). The ability of the EMS team to prosecute illegal dumpers in some cases, served to reward employees for their vigilance and reinforced the belief that environmental involvement was worthwhile.

6.5.4 Creation of two tiers

The discussions above suggest that employee involvement was straddling some difficult issues during the study with old work practices and recent organisational changes influencing the effectiveness of the approaches taken. While the developmental opportunities for employees were positive, the analysis further suggested that there could be a danger of creating a two-tier outcome based on an unequal availability of opportunity.

It was observed that the employees managers chose to involve in environmental work, had pre-existing skills and capabilities that the manager deemed to be appropriate; a typical comment was:

> "... for the standard of auditors we deliberately picked a level of person with certain skills and abilities... we picked people [who we felt] had a good knowledge of one particular facet of the business." Transcript # 18

While at a more strategic level this would appear a logical choice, at an operations level some managers were in danger of reinforcing existing knowledge barriers and reducing learning opportunities by 'preaching to the converted':

> "When a manager picks someone to become their environmental officer, you don't pick the person who is least caring, you pick the one who has got the greenest wellies." Transcript # 9

This tendency to chose those people who already had or were in the process of gaining environmental knowledge meant the managers were perhaps reducing their available pool of employees that could be involved in environmental tasks:

> " I chose my two co-ordinators on the basis of auditor training and involvement in CPI." Transcript # 10

These comments suggest that managers were under pressure to satisfy involvement criteria and did not necessarily have the time or opportunity to consider a more equitable distribution of responsibility. Instead, they preferred to adhere to existing levels of responsibility involving staff with supervisory roles, rather than drawing in employees with less experience. However, this decision making process was also driven by the need to avoid raising expectations, as one senior manager explained:

> "The trouble is when you start off you say you are going to involve everybody [in environmental work] inevitably you can't, so people have been given enthusiasm because you've told them that they can be involved in something new and then nothing happens and they get disillusioned." Transcript # 12

Striking the balance, in order to develop and sustain interest in environmental work was evidently an additional burden for hard-pressed operational managers.

6.5.6 Summary

The evidence presented above suggested that employee involvement in environmental work was a key part of the ESH initiative and was being more broadly pursued through the company's new commitment to IIP. At site level, involvement was viewed as a necessity by managers to meet the increased demands on time and resources imposed by the company's drive towards a formal EMS. On an intellectual level, a number of managers clearly saw and were making use of the opportunity to progress and develop staff. However, in doing so, some managers were also aware of the difficulties of ensuring equal availability of opportunity.

6.6 Environmental Awareness

6.6.1 Background

I suggested in chapter three (section, 3.3.4) that authors have argued for and supported the view that improved environmental awareness across the organisation is an important prerequisite for the successful delivery of an environmental management programme. I have also noted however, that environmental concepts are difficult to define and capture at levels appropriate for different workers, tasks and competencies.

So while raising awareness may be considered a key starting point for any EMS, putting in place the appropriate knowledge presents a particular problem.

At ECC little formal environmental training took place prior to the decision to implement the ESH initiative (as noted in section 6.2). Following the launch of the ESH initiative the company committed to train the entire workforce, aiming to reach 80% of them by the end of 1998 and the remainder by March 1999 (*fn 29.5.98*). This training was to be undertaken by a selected training provider (chosen jointly by the EMS team and the manager responsible for IIP) and delivered at two different levels. The training that the individual would receive was determined by their place in the organisational hierarchy.

Managers and staff at a more senior level were to undertake a five-day course, of which one day would comprise environmental training. The majority of the workforce, including all operational and office based staff, would undertake a one day course which was to include some basic environmental awareness training. In addition, the EMS team embarked on a series of managerial briefings to operatives at site level conducted on site (discussed further below).

Analysis of these activities and their effectiveness generated several clear themes during the study. First, several issues emerged relating to how the communication of environmental messages was undertaken. Second, analysis of the data suggested significant variations in the levels of environmental awareness across the organisation. These issues are explored in turn below.

6.6.2 Communication

Environmental management texts that deal with environmental issues in business, frequently suggest that companies should employ a combination of traditional and innovative mechanisms to raise environmental awareness (Crosbie and Knight, 1995). At ECC there was a strong consensus among managers that the most effective and efficient means of raising awareness was to speak to employees directly. One senior manager, in particular, felt that raising awareness levels was one of the company's greatest challenges in relation to environmental management for the forthcoming years and he commented that:

> "To communicate effectively you need to allocate plenty of time and have a really good programme for doing it. People become immune to it [communication by 'traditional' classroom methods] and by far the most effective means of communication is face-to-face. When you have a workforce of 3000 that is a bit difficult." Transcript # 12

Highlighted here is the intrinsic problem of resources and logistics that accompany a programme of this nature. However, for this manager, the immediacy of this form of communication outweighed some of the real time costs involved for him personally as He further commented:

> "... at least with face-to-face discussion you can tell whether they understand, agree and are going to actually go out and act on what you have said, and this is really important with environmental stuff..." Transcript # 12

These sentiments were echoed by several operations managers, who also related to this problem of balancing an efficient delivery of the message with the obvious time penalties incurred. Their remarks include:

> "Everybody accepts that managers need to spend more time briefing their employees [on environmental matters]. We know that managers need to spend more time walking the job." Transcript # 11

> " I think the environment is like safety. You have just got to keep plugging away, and if you see something you mention it to the guy you are with and if you are in a meeting and the topic comes up you put it on the agenda." Transcript # 15

> "You can't have too much communication can you? The thing that limits it is the time available and the methods used." Transcript # 11

Conversations with managers indicated that it was largely their accumulated experience with, and personal knowledge of, their workforce that supported this view. In their experience, workers usually welcomed the opportunity to speak to managers directly about new issues and it was clear in some cases that managers were increasingly conscious of the divisions between hierarchies (reported above in section 6.5). Several also commented on the dramatic spread of educational ability on site ranging from degree level, to workers with no formal qualifications. This spread could, in their opinion, dramatically impact the effectiveness of 'average common denominator' document based training and had served to reinforce their belief in direct communication.

To this end the EMS team senior manager embarked on a series of environmental briefings to operatives on site. The briefings covered a range of issues including: the strategic, company rationale for an EMS; the cost and legal issues of environmental work; individual and collective responsibilities; and site specific concerns. Observations of these briefings supported the managers views that direct communication worked well in this context (*fn 19.6.98*). Operatives were forthcoming with personal experiences (for example, of minimising dust blow) and appeared to benefit from grounding some of the issues raised in their own personal experiences. It was, nevertheless, interesting to observe how the quality derived from the briefing experience, was impacted by basic pragmatic issues such as timing. Put simply, observations of briefings suggested that operatives at the beginning of shift work were more receptive and enthused than those coming off shift. This implied that if briefings were to be most effective they needed to be carefully scheduled.

The study period marked the beginning of the ESH training period and consequently there was limited opportunity to reflect with workers on the quality of the training. Most of the managers questioned were waiting until all their staff had taken the course before undertaking the training themselves. One manager did note that:

> "They have all come back and said yeah, really enjoyed it, excellent course. But in terms of saying 'we've got to do this now', or 'I was thinking about this down there' there has not been much of that. I haven't had a queue of people at the door..." Transcript # 11

In his opinion, this was slightly unusual and had prepared him to be more attentive to the course content when attending the sessions. Interestingly though, in interviews with a number of staff who had taken the one day course, several did not recall that any environmental details had been provided as part of the training (Transcript # 3). These early indicators pointed to the need for a review and revision of course content and delivery for the future.

6.6.3 Variability

The company aimed to achieve blanket coverage through its ESH training and awareness raising initiative. In doing so the aim to was to achieve a baseline level of environmental awareness relating both to personal responsibility and the aims of the organisation with respect to the ESH initiative as a whole. Evidence collected during the study suggested however, that environmental awareness levels in the organisation were

(following a period when most personnel had passed through the training programme) both variable and patchy.

One of the key issues that several managers were struggling with was finding the balance between communicating strategic level, contextual information and more site-specific concerns. These tensions were expressed by a scientist and senior manager who said respectively, that:

> "One thing that we have not got out on the production sites is an overall awareness of the environment as a whole." Transcript # 7
>
> "It is the attitude out on the works ... they don't have the big picture." Transcript # 12

These comments served to reinforce a broader observation that I made during the study, that much of the intellectual capacity to conceptualise environmental issues (in particular the ability to see both the holistic picture and the site level detail) resided in a small number of key personnel at the company. Furthermore, these identified gaps were not restricted to site level personnel, as some interviews with senior managers also showed a very limited view of environmental management issues.

Past practice additionally played its role in maintaining the 'status quo', in terms of what workers felt they were required to know. For some workers at the operational level, organisational restructuring and the rolling-out of initiatives had, in reality, had little impact on the actual tasks they undertook. As a consequence they felt little need or urgency to reform their working practices in line with environmental concerns. As a senior operations manager indicated:

> "It is difficult to convince people of the urgency when nothing ever happens. It might be 'well I've been here for 30 years and it has never happened yet'... and trying to convince them that it [a significant environmental incident] might happen tomorrow is hard." Transcript # 14

Again, as noted above, this denial of need was also present in more senior staff, one of whom commented that:

> "It [environmental pressure] is a general, rather than a specific thing. We are generally aware that there is an increase in pressure to do such another, but it is obviously going to be more significant in 3-4 years time." Transcript # 6

This suggested that even amongst senior staff, the immediacy of environmental pressure for the company was not necessarily fully understood. This point was reinforced by a member of the EMS team who observed that:

> "It is whether there is a recognition that the environment [as an issue] has financial implications [if not managed properly]. It is probably a question that has not been grasped fully in certain areas of the business." Transcript # 7

Although much of the training activity was directed at improving awareness out at site level (where environmental issues were at their most acute) baseline environmental awareness was also notably lacking in a number of office staff who had designated environmental responsibilities:

> "Oh yes we have a whole environmental team down there [in the other offices] ... I don't know how many there are." Transcript # 3

> "I mean offhand I don't know who the senior manager responsible [for environmental issues] is." Transcript # 8

This range of perspectives from the qualitative element of the study, suggested that awareness levels varied considerably across the organisation. However this variability is less apparent in the quantitative data which surveyed a broader sample of the organisational population.

6.6.4 Shared understanding

The project questionnaire sought to obtain an overview of baseline company environmental awareness using four basic indicators. The questionnaire required respondents to: identify possible areas of environmental impact; rank impact significance; rank the significance of a predefined list of constituents or stakeholders and rate the company's spatial impact using a multi-item measure (see chapter 4, section 4.6.2).

Question 1 asked respondents to identify a range of factors on which the company's operations could impact and then rank the top five areas of impact (where 1 = the highest impact and 5 = the lowest impact). Analysis of the frequency data indicated that between 70–100% of all respondents were able to identify the four main physical media, landscape, habitat, air and water as being impacted by company activity. A high percentage of respondents also felt confident that human beings (75%) and transport

(71%) would be impacted by company operations. More equivocal though, were responses with respect to socio-economic and cultural factors such as housing (52%) and cultural heritage (31%). These identification trends were also mirrored in the way respondents ranked the significance of these impacts.

Descriptive statistics for the entire data set showed that respondents ranked the company's impact on the landscape as most significant with habitat, water and air in descending order of significance (see Appendix iv). Analysis of the variance across the data set by position of the respondent in the hierarchy, functional group, business unit and by their length of service in the company (using one-way ANOVA) revealed no significant differences between the relative rankings of each group.

The findings suggest that most staff understand and are aware of the company's key environmental impacts on the landscape in particular, and the other physical media (air and water). This is not surprising as the respondents' views broadly reflect company priorities and rhetoric as well as the historical slant of environmental improvement programmes to date.[10] Lower awareness levels of impacts on socio-economic factors are more unexpected as company activities have long fashioned the built infrastructure of area, including the creation and preservation of heritage sites (CAU, 1992). That these perspectives hold consistently both vertically and horizontally throughout the organisation is also surprising as I would have expected to see some variations between functions and also perhaps between recent and more long serving staff. Again this lack of variation suggests that existing company priorities towards environmental management are widely recognised and understood, and that perceptions have not yet altered in the light of newer environmental management initiatives.

This point is illustrated by a qualitative comment from a questionnaire:

> "I think ECC are trying to be more environmentally friendly but apart from tip restoration I have no idea what else they do." *qn (300)*

Question 2 asked respondents to rank a predetermined list of constituents according to their (the constituent's) interest in the company's environmental impacts. Descriptive

[10] The company's long standing environmental brochure 'Back to Nature' focuses largely on impacts on landscape and the restoration techniques employed (ECC, 1987).

statistics identified an average ranking across the data set where in descending order; the local community were considered to be the most interested, followed by interest groups, regulators, customers and shareholders (see Appendix iv). As above, an analysis of variance across the data set by hierarchy, function, business unit and environmental responsibility revealed no significant differences between the groups, with this pattern being maintained throughout. These findings are particularly interesting as they illustrate the strength of feeling and respect for the views of the local community within the company. As one respondent added:

> "The company should be as concerned about its relationships with local communities as it is about fulfilling its legal responsibilities towards the environment." *qn (440)*

The findings are also surprising as I would have expected to see some variation, for example, in relation to those working in marketing and sales and their rating of customer interest. An analysis I conducted during the study, of ECC customer environmental requests, indicated a steady growth in customer interest in environmental issues particularly from some of the company's key accounts.[11] An environmental 'audit' from a major customer during 1998 also lent weight to the ability of customers to influence environmental practices. However these findings suggest that such environmental concerns had yet to filter beyond the people most immediately concerned with the management of environmental issues.

Question 3 asked respondents to rate the company's spatial impacts across five geographical levels (local, regional, national, Europe and international) using a five point Likert scale, (where 1= not important and 5= very important). Analysis of the data revealed a pattern towards impacts being on average very important at a local level (4.71) important at a regional level (4.21) and less important at a national (3.07), European (2.70) and international (2.43) level respectively. While no significant differences emerged when these averages were compared across organisational function, significant differences ($p = < 0.05$) were revealed when compared by hierarchy (where hierarchy 1 = most senior and hierarchy 4= least senior) with respect to the European and international categories. These statistics are illustrated in Figure 6.7.

[11] Thomas (1997) 'Environmental Questionnaires' (supporting document for transfer from MPhil to PhD status, University of Bath School of Management).

Significance levels are calculated using one-way ANOVA (see chapter four, section 4.8.2).

Factor	Hierarchy 1	Hierarchy 2	Hierarchy 3	Hierarchy 4	Overall Mean	F
Inter-national	1.50	2.07	2.42	2.82	2.43	9.75**
Euro.	1.79	2.40	2.71	3.04	2.70	8.92**
National	2.50	2.91	3.12	3.19	3.07	2.83*
Regional	4.00	4.16	4.30	4.20	4.21	1.26
Local	4.86	4.79	4.66	4.63	4.71	2.15
n=	14	116	122	110		

*Figure 6.7: Importance of Environmental Impact at Different Geographical Levels by Hierarchy (*p<0.05, **p<0.01).*

These findings suggest that workers at an operational level are more likely to consider the company's environmental impacts to be important beyond national boundaries. This perspective fits company rhetoric of its international profile and world wide customer base. Surprising then is the finding that senior staff do not share this view so strongly. This is interesting, as much anecdotal evidence gathered during periods at the company, pointed to any regional and national biases being most prevalent among operational staff. These findings suggest the contrary, although they also may indicate the broader overview afforded to senior staff who could have made the assessment that, in spite of growing environmental pressures, company impacts are most closely scrutinised nearer to home.

6.6.5 Summary

The raising of environmental awareness was recognised by the company to be a major hurdle on the route to the successful pursuit of environmental objectives. Analysis of the qualitative data in this section points to the importance of the communication mechanism when attempting to raise awareness in this case context. It also illustrated the value of managerial experience in identifying the best methods of communication. I have suggested that several subsidiary factors including the relationships between

managers and their employees, and the timing of worker briefings, could have a significant impact on the quality of the message delivered and its received value.

In spite of the uniform training programme provided, variation was evident both between operations and senior staff and within the ranks of senior staff themselves. This variability was also characterised by an inability to connect site level detail with the 'bigger picture'.

This variability of environmental awareness is less evident from the analysis of the quantitative data. Employees appear to share a similar understanding of the areas where the company's operations impact, with a strong bias toward the physical media (air, land and water). Comprehension of the importance of key stakeholders is focused on local interests and, for both sets of issues, these perspectives do not vary significantly either vertically or horizontally across the organisation. Some significant variation emerges between the hierarchies when considering the employee's perspective of the company's spatial impacts. These findings are surprising when contrasted with contextual data gathered during periods in the field.

6.7 Environmental Values

6.7.1 Background

In chapter three (section 3.3.5) I presented an analysis of the extant literature which suggested that it is individual, personal values collectively that fashion organisational culture. Additionally, I argued that a number of studies have pointed to evidence that individuals embrace environmental issues, heightened through broader societal concern, more readily than organisations. Significantly therefore, it was implied that organisations whose environmental activities lag behind the aspirations of its workforce, can expect to see sub-optimal performance in these areas.

At ECC, the ESH initiative of 1997 appeared to mark a turning point. For the first time, the company could be seen to be strategically committing to environmental improvements. Prior to the appointment of a director and senior staff with environmental responsibilities, there were arguably limited signals from senior levels that environmental concerns should be a part of the cultural agenda in the organisation.

For example, a commitment to environmental improvement was notable by its absence from the company's published 'Mission, Values and Working Principles', a leaflet outlining company 'values' which was distributed to all existing and new staff.[12]

Questions surrounding the 'depth' of this new commitment to change also arose during the study in conversation with several members of the EMS team, and operations managers assigned to direct and implement much of the core environmental activity. In particular it was felt that environmental activity was (for senior managers) being driven primarily by threats, as outlined in the consultancy report, rather than by a recognition that environmental work had the potential to be an intrinsically valuable and important part of mineral production in the long term. These impressions, gathered through periods in the field, suggested that concern for the environment was developing differently between levels in the organisational strata and functions.

In order to explore these areas further the project questionnaire sought to obtain a perspective on both personal and perceived corporate environmental values as expressed by individuals across the organisation at the time of the study.[13] To throw light on this issue, I chose in the analysis, to look for differences between these two sets of values and to compare them across organisational functions and hierarchy. The results of these analyses are presented below (descriptive statistics for the data set can be found in Appendix iv).

6.7.2 Personal and Perceived Corporate Values Examined: Environmental Factors

Questions 4 and 6 of the questionnaire created two samples where respondents were asked to rate from a personal and corporate perspective, the importance of particular values (transposed as organisationally relevant factors, tip restoration, pipeline burst containment, employee safety and community relations). A five point Likert scale was used for rating purposes (where 1 = not important and 5 = very important).

When comparing the *personal values* of respondents across the *hierarchical layers* (where hierarchy 1 = most senior and hierarchy 4 = least senior) using one-way ANOVA,

[12] Interestingly, the American leaflet, which acted as a blueprint for the UK version, included environmental concerns as part of the (US) company core values.

[13] For an explanation of the questionnaire and construct development, refer to chapter four, section 4.6.

some significant differences emerge.[14] While there is little significant difference between personal values when considered by hierarchy in relation to tip restoration and employee safety (p = 0.34 and p = 0.45 respectively) there are differences between the hierarchies in relation to pipeline burst containment and community relations, as shown in Figure 6.8.

Factor	Hierarchy 1	Hierarchy 2	Hierarchy 3	Hierarchy 4	Overall Mean	F
Pipe. Burst	4.29	4.09	4.43	4.27	4.29	3.31*
Com. Rel.	4.71	4.37	4.45	4.23	4.38	2.70*

Figure 6.8: Personal Values: Pipeline Burst Containment and Community Relations by Hierarchy (n = 365) (n = 366) (*p<0.05).

While each hierarchy appears to rate pipeline bursts as important, average ratings for hierarchy 2 are, on the Likert scale, relatively below those for the other levels. This is an interesting finding, as hierarchy 2 includes operational managers, whose responsibilities include the strategic management of environmental incidents of this nature. Of all the hierarchy groups, these employees would be expected to rate this factor most highly. The issues relating pipeline burst are outlined in more detail in chapter eight (section 8.5.3). The higher personal ratings of employees in hierarchy 3, may be explained by the likelihood that employees at this level (for example, technicians and engineers) are more proximal to the operations and therefore have greater practical experience and personal interest in finding appropriate solutions.

Personal values for community relations also exhibit high average ratings as shown in Figure 6.8. and also lie closely together on the Likert scale. While high personal values in this context for hierarchy 1 may reflect the broader perspective afforded to senior staff, the differences between hierarchies are statistically significant at a 5% level. The lower values for hierarchy 2 are surprising because, as indicated above, this level encompasses staff involved in strategic decision-making and liaison with stakeholders.

[14] See chapter four, section 4.8.2, for an explanation of statistical test choice.

Lower mean values are also shown for hierarchy 4 which includes operatives and site workers, who by the nature of their job, have the most immediate and direct contact with neighbouring communities. Lower personal interest in this group of workers, although not unexpected based on their roles and responsibilities, has the potential to negatively impact the relationship with the local community.

An examination of perceived *corporate values* in relation to these four environmental factors reveals significant differences between the hierarchies on the factors of employee safety and community relations. As observed above, average scores for employee safety are also consistently high and relatively close together. There are, however, significant differences between the hierarchies that are most marked between the highest and lowest levels (see Figure 6.9). In particular, employees in the lowest level, hierarchy 4 consider that the company rates employee safety less highly than senior staff, in hierarchies 1 and 2. This may reflect the general 'air' of de-motivation at an operational level reported during the study and discussed in the case context chapter five. Relatively high ratings for senior staff are to be expected, and it is also important to note that the survey took place prior to a major company drive designed to raise the profile and awareness of employee safety throughout the organisation.

Factor	Hierarchy 1	Hierarchy 2	Hierarchy 3	Hierarchy 4	Overall Mean	F
Emp. Safety	4.71	4.54	4.45	4.24	4.39	3.97**
Comm. Rel.	4.00	3.98	3.80	3.61	3.78	3.15*

Figure 6.9: Perceived Corporate Values: Employee Safety and Community Relations by Hierarchy (n = 366) (*p<0.05, **p<0.01).

This difference between the hierarchies is also reflected in how employees see the company's values with respect to community relations (see Figure 6.9). While average ratings for senior staff (hierarchies 1 and 2) suggest that perceptions of corporate value in relation to the community are high, the perspective from hierarchy 4 is more equivocal, being closer to the central point on the Likert scale. The figures for hierarchy 1 and 2 follow expectations, that is, senior staff are more likely to see the company as

valuing external relationships highly. It is interesting to observe the significantly lower perceptions of employees at an operational level. A possible explanation for this finding may be found in the observed disenfranchisement of operational level employees. It may also reflect their more direct experience of how this relationship is actually managed on the ground and, therefore, could be an expression of the gap between company rhetoric and reality.

The analysis presented above, shows that significant differences exist in relation to three factors (pipeline burst, community relations and employee safety) when the personal values of employees and their perceptions of corporate values, are considered individually across the different hierarchical groups in the company. In order to pursue these findings in more detail, a *composite* measure was created using the Statistical Package for Social Scientists (SPSS) that allowed these two data sets to be compared directly (see also, section 6.3.1). Specifically, the measure calculated the difference between the two sets of values, where the difference was equal to perceived corporate values minus personal values. This may be expressed as x3=x2-x1. Positive, mean results would suggest that the company valued the factor more highly than the individual. Negative, mean results would point to the company valuing the factor less highly than the individual. These composite results could then be analysed using one-way ANOVA to determine whether significant differences existed between the groups in relation to hierarchy.

	Hierarchy 1	Hierarchy 2	Hierarchy 3	Hierarchy 4	F
Employee Safety					
personal values x1	4.92	4.76	4.84	4.87	
perceived corporate values x2	4.71	4.53	4.45	4.24	
x3=x2-x1	-0.21	-0.22	-0.39	-0.62	5.42**
Community Relations					
personal values x1	4.71	4.37	4.45	4.23	
perceived corporate values x2	4.00	3.98	3.80	3.61	
x3=x2-x1	-0.71	-0.38	-0.65	-0.62	1.46
Pipeline Burst					
personal values x1	4.29	4.09	4.43	4.27	
perceived corporate values x2	4.29	4.18	4.36	4.10	
x3=x2-x1	-0.71	-0.38	-0.65	-0.62	1.50

*Figure 6.10: Composite Measure of Personal and Perceived Corporate Values: Employee Safety, Community Relations and Pipeline Burst by Hierarchy (n=366) (**p<0.01).*

Figure 6.10 shows the results of this analysis using the composite measure for each of the three factors identified as being of interest in the preceding analysis (pipeline burst, community relations and employee safety). The Figure illustrates the mean values for the data sets when considered individually, as well as the results of the composite measure analysis. The results show that, while the pattern across each factor and hierarchy is for the company to value the factors less highly than the individual (negative mean results) there are no significant differences between the groups with respect to community relations and pipeline burst.

The results do, however, indicate that significant differences exist between the hierarchies with respect to employee safety. In particular the Figure suggests that there

may be a difference between the results for operational level workers in hierarchy 4 and the more senior staff represented in hierarchies 1 and 2. As the results of ANOVA cannot determine that this is exactly where the differences lie, an appropriate *post hoc* test is necessary (Field, 2000). Analysis using Duncan's *post hoc* range test (Foster, 1998) supports this initial inference by confirming that the differences between the means reported for hierarchy 4 and hierarchies 1 and 2 are indeed significant (=0.05: hierarchies 1 and 2 < hierarchy 4) and are therefore supported.

These specific findings with respect to the employee safety factor are important because they provide support for other, qualitative evidence (section 6.5.1 and section 8.2.2, chapter eight) that there may be a mismatch of values between the hierarchies in areas of high personal concern. This could be contributing to the de-motivation of operational level workers observed during the study. The non-significant findings are also illuminating because they show that, even where employees consider the company to value key environmental factors less highly than they do personally, this perspective is shared across the different levels of the organisation. An understanding of this congruent perspective is important to ongoing efforts for environmental improvement.

The preceding analysis examined the 'values' data sets both individually and as a composite measure according to hierarchical groups. The classification questions on the questionnaire also allow a grouping and analysis of the survey sample by *organisational function*. Examining how *personal values* differ with respect to the four factors but according to *organisational function* (as outlined in chapter 4, section, 4.8.2) using one-way ANOVA reveals no significant differences between the groups for either the tip restoration (p =0.29) or employee safety (p=0.07) factors. However comparing personal values across the functions with respect to pipeline burst containment and community relations sees some significant differences emerge.

Figure 6.11 shows how personal values for the euroboard (company senior managers), product supply and finance with respect to pipeline burst, are on average higher than those for the other functions, in particular sales and marketing (on a scale of 1-5 where 1=not important, 5=very important). That the personal values of employees in the former functions are high, suggests an awareness and experience of, the reputational, actual and practical costs respectively, of dealing with burst pipelines. These findings

therefore follow expectations. The, on average, lower personal values of the office based functions of sales, marketing and logistics suggests that a lack of practical experience with these incidents can influence personal perspectives.

Function	n=	Mean	Overall Mean	F
sales	21	3.81	4.29	3.31**
marketing	16	3.81		
logistics	32	4.06		
technology	65	4.17		
central research laboratory	29	4.21		
IT	22	4.23		
human resources	29	4.31		
product supply	169	4.47		
finance	17	4.53		
euroboard	7	4.71		

*Figure 6.11: Personal Values: Pipeline Burst Containment by Function (n= 407) (**p<0.01).*

Personal values with respect to community relations also show significant differences when compared by function. As Figure 6.12 illustrates, while averages are high, the euroboard, human resources and product supply functions exhibit relatively strong personal interest in this factor. It is interesting to observe that it is those closest to the production, mining function of the organisation who appear to have the most highly developed personal environmental values. Again it is important to treat these figures with some caution as the findings may reflect a perceived need for employees in these functions to be receptive to the local community, rather than an actual personal value.

Function	**n=**	***Mean***	***Overall Mean***	***F***
IT	22	4.09	4.39	2.15*
logistics	32	4.12		
marketing	16	4.19		
central research laboratory	29	4.24		
finance	17	4.35		
technology	65	4.35		
sales	21	4.38		
product supply	170	4.46		
human resources	29	4.62		
euroboard	7	5.0		

*Figure 6.12: Personal Values: Community Relations by Function (n=408) (*p<0.05).*

If we examine employee perceptions of *corporate values* with respect to the four factors by function, significant differences emerge across the organisation sectors for tip restoration (p=0.00), employee safety (p=0.00) and community relations (p=0.02). However, in each instance the mean figures across all the functions are high (above 3.50) and this suggests a degree of 'strategic responding' and the need to treat the figures with some caution. Nevertheless, in a reflection of the findings for personal values illustrated in the Figures above, it is the product supply, euroboard and human resources functions which again, exhibit the highest values. Similarly, the office based functions of sales, marketing and research all show the lowest averages across each of the factors.

This observed 'mirroring' of personal and perceived corporate values, and in particular the consistently high average means, is confirmed when analysis is conducted across the four factors using the results of the *composite* measure. One-way ANOVA suggests that there is no significant difference between the functional groups for tip restoration (p=0.26), pipeline burst containment (p=0.09) and community relations (p=0.80). This supports the previous findings in relations to the hierarchical groupings and suggests personal and perceived corporate values are broadly aligned across these factors. Interestingly, analysis of the composite measure by function does reveal significant

value differences between the groups for employee safety (p=0.01). This confirms the mismatch of values on this factor reported above (in Figure 6.10) and suggests that this finding is pertinent both vertically and horizontally in the organisation.

6.7.3 Personal and Perceived Corporate Values Examined: Organisational Factors

Questions 5 and 7 of the questionnaire created a sample where respondents were asked to rank (on a scale of 1-5 where 1 = most important and 5 = least important) from a personal and corporate perspective, the relative importance of five predetermined factors: creativity; environment; product quality; people and profit. These factors were based on the company's own published 'Mission, Values and Working Principles' document.[15]

Looking first at the *personal values* of respondents across the *hierarchical layers* using one-way ANOVA, no significant differences are uncovered between the hierarchies for personal values with respect to creativity, product quality and people. Some significant differences, however, emerge in the way different hierarchies rank the factors of environment and profit. Examining personal values with respect to the environment factor, reveals that lower hierarchies appear to exhibit significantly stronger personal values toward the environment than more senior employees, as shown in Figure 6.13. This suggests that a strong personal environmental ethic may exist among operational staff.

Factor	Hierarchy 1	Hierarchy 2	Hierarchy 3	Hierarchy 4	Overall Mean	F
Env.	3.86	3.66	3.38	3.02	3.38	6.83**
Profit	2.64	3.0	3.44	3.58	3.32	4.39*

*Figure 6.13: Personal Values: Environment and Profit by Hierarchy (1= high value, 5= low value, n=347) (*p<0.05, **p<0.01).*

Significant differences also exist between the personal values of hierarchies with respect to profit, as illustrated in Figure 6.13. However, in this instance the dichotomy exhibited above is reversed with senior staff valuing profit more highly from a personal

[15] For an explanation of construct development, refer to chapter four, section 4.6.2.

perspective that lower level and operational workers. This suggest that there may be some clear differences between personal incentives in the work environment when viewed from this perspective and this may be a reflection of the varied levels of responsibility and authority in the organisation. These findings for profit do, however, run with expectation, to the extent that senior personnel are more likely to have an overview of company revenues and, in most instances, have personal performance indicators attached to profit targets.

Examining employees' perceptions of *corporate values* across the hierarchical layers, reveals significant differences between respondents, with respect to the environment and people. When considering the environment, it appears that senior staff, in particular those with managerial and operational responsibilities (present in hierarchy 2) consider company values with respect to the environment to be less strong than their colleagues at lower levels in the organisation (see Figure 6.14). This is interesting as it runs counter to expectations. It was anticipated that employees at more senior levels would with their greater understanding of corporate policy and activity in the environment arena, regard company environmental values more highly. It may, therefore, be a reflection of the greater understanding that employees at this level have about actual corporate commitment (capital and human resources) to the environment. The figures are also interesting as each hierarchy consistently considers company environmental values to be relatively low (in relation to the other factors).

Factor	Hierarchy 1	Hierarchy 2	Hierarchy 3	Hierarchy 4	Overall Mean	F
Env.	4.00	4.24	3.88	3.86	3.40	4.19*
People	2.57	3.00	3.40	3.43	3.28	5.26**

*Figure 6.14: Perceived Corporate Values: Environment and People by Hierarchy (n=348) (n=349 (1=high value rating and 5=low value rating, n= 348) (*p<0.05, **p<0.01).*

Significant differences also emerge between the hierarchies with respect to how the company values its employees or people. An examination of Figure 6.14, suggests that employees in hierarchy 4, who work in site level and administrative positions see the

company as valuing its people less strongly than senior level staff. This confirms some of the arguments previously put forward in chapter 5 (section 5.4.1) that there exists a discernible level of disenfranchisement throughout the organisation and in particular amongst operational-level workers.

The analysis presented above shows that significant differences exist in relation to three organisational factors (environment, people and profit) when the personal values of employees and their perceptions of corporate values are considered individually across the different hierarchical groups in the company. Following the procedure described in section 6.7.2, a composite measure was created in SPSS that allowed the two 'values' data sets to be compared directly. As previously, these composite results were then analysed using one-way ANOVA to determine whether significant differences existed between the groups in relation to hierarchy.

Figure 6.15 illustrates the results of this analysis, using the composite measure for each of the three factors identified as being of interest in the preceding analysis (environment, profit and people). The Figure illustrates the mean values for the data sets when considered individually, as well as the results of the composite measure analysis. The results show that, the pattern across the environment and profit factors is for the company to value those factors less highly than the individual (negative mean results). The results for the profit factor suggest that, across the hierarchies, the company is viewed as valuing profit more highly than the individual (positive mean results).

	Hierarchy 1	**Hierarchy 2**	**Hierarchy 3**	**Hierarchy 4**	**F**
Environment					
personal values x1	3.86	3.66	3.38	3.01	
perceived corporate values x2	4.00	4.24	3.87	3.85	
x3=x2-x1	-0.14	-0.63	-0.49	-0.84	2.32
People					
personal values x1	2.14	2.09	2.03	2.13	
perceived corporate values x2	2.57	3.06	3.40	2.13	
x3=x2-x1	-0.43	-0.94	-1.37	-1.30	2.76*
Profit					
personal values x1	2.64	3.00	3.44	3.58	
perceived corporate values x2	2.07	1.42	1.49	1.53	
x3=x2-x1	0.57	1.61	1.95	2.05	4.37**

Figure 6.15: Composite Measure of Personal and Perceived Corporate Values: Environment, People and Profit by Hierarchy (n=346) (p< 0.05, **p<0.01).*

The results indicate that any differences between the hierarchies in relation to the environment factor are non-significant.[16] The results also show, however, that significant differences exist between the hierarchies with respect to both the people and profit factors. In particular, senior managers (hierarchy 1) appear to be expressing significantly difference values from operational level workers (hierarchies 3 and 4). These ANOVA results are supported by a Duncan's range test which shows that for the profit factor (=0.05: hierarchy 1 < hierarchies 2,3 and 4) and for the people factor (0.05: hierarchy 1 < hierarchies 3 and 4).

[16] The figures for environment, while not statistically significant do however display the same general patterns reported when personal and corporate values were considered independently, i.e. hierarchy 4 in particular, considers that the company values the environment less highly than they do.

These findings are interesting as they reflect the qualitative data relating to the observations of low worker morale at the operational level, discussed in sections 6.5.1 and 8.2.2. They also support anecdotal evidence gathered during periods in the field, that the company's drive for profits was (in the eyes of its operational level workforce) being achieved at the expense of investment in its employees. Again, these findings tally with previous observations of employee disenfranchisement at the lower levels of the organisation. The finding that there is no significant difference between the groups with respect to the environment factor is also important, as it point to a strong and pervasive, personal environmental ethic throughout the different hierarchical levels.

As noted previously, the classification questions on the questionnaire also allow a grouping and analysis of the survey sample by *organisational function*. Analysis of *personal* values with respect to the five factors by *function* revealed no significant differences. This suggests a strong level of personal value congruence horizontally across the organisation for these five factors. Analysis of perceived *corporate* values with respect to the five factors by *function* also showed little significant differences with the exception of the creativity and profit factors. For the creativity factor the following functions; sales, product supply, technology and the central research laboratory in particular, considered the company to value this factor of less importance when compared with the other functions (see Figure 6.16). This is an important finding because it suggests that workers for whom creativity is an important route to problem solving may feel constrained because, in their perception, the company does not value this aspect of their work highly.

For profit, all functions saw the company as valuing this factor very highly with particularly high values being reflected by the central research, sales and marketing functions when compared to the other functions (see Figure 6.16). These findings may provide an indication of where the pressures for profit generation are felt most keenly.

	N=	Mean	Overall Mean	F
Creativity				
euroboard	7	3.28	4.04	3.03**
marketing	15	3.53		
IT	22	3.55		
logistics	29	3.59		
finance	17	3.88		
human resources	28	3.93		
sales	20	4.05		
CRL	29	4.10		
technology		4.16		
product supply	161	4.24		
Profit				
CRL	29	1.17	2.14	3.25**
IT	22	1.22		
marketing	15	1.33		
sales	20	1.35		
product supply	161	1.45		
technology	62	1.47		
finance	17	1.53		
logistics	29	1.79		
human resources	28	2.11		
euroboard	7	2.71		

*Figure 6.16: Perceived Corporate Values: Creativity and Profit by Function (where 1= a high value rating and 5= a low value rating, n=390) (**p<0.01).*

Analysis by *function* using the composite measure revealed little significant differences across the environment, product quality and people factors, suggesting limited disparity between personal and perceived organisational values. However significant figures in relation to creativity ($p = 0.03$) and profit ($p = 0.01$) suggested that the central research laboratory in particular, felt that the company valued creativity less highly than they did personally and that the company valued profit more highly than they did personally. When the independent (function) variable was reconfigured according to business unit

and compared using one-way ANOVA, significant differences were again found for the central research facility with respect to the creativity factor providing additional support for these findings. This evidence is broadly as anticipated with research staff being expected to value their creative space more highly. This disparity between personal and perceived organisational values with respect to the creativity factor is, however, an important issue in this case, and is supported by qualitative data that is considered in chapter eight, section 8.2.3.

6.7.4 Organisational Value Statements

Question 8 of the questionnaire comprised nine value statements, developed on the basis of resource characteristic conceptualisations, which respondents could agree or disagree with on the basis of a five point Likert scale (where 1=strongly agree and 5=strongly disagree). Agreeing suggested positive organisational environmental values and disagreeing the converse. Mean values across the whole data set for these statements (Figure 6.17) show that six of the nine statements yielded positive responses and that three yielded on average negative response.

Question 8: Statements	**Overall Mean**	**Standard Deviation**
a *environmental management is a necessary part of ECC's operations*	1.55	0.61
i *environmental management is a business concern at ECC*	2.32	0.81
c *ECC works in partnership with both private and public sectors organisations to find solutions to environmental problems*	2.34	0.72
d *ECC considers the environment when designing new project and creating new products*	2.53	0.95
e *ECC has clear, understandable environmental objectives*	2.60	0.91
h *environmental protection is an integral part of ECC's quality system*	2.63	0.87
b *at ECC employees help in the design of environmental training programmes*	3.30	0.90
g *at ECC departments share environmental best practice*	3.31	0.89
f *ECC involves employees at all levels in the development of environmental projects*	3.56	0.89

Figure 6.17: Mean Values for Question 8, Statements a- i (1=high value rating, 5 = low value rating, n= 415).

The statements that showed on average a more neutral response (statements b, g and f, see Figure 6.17) all related to facets of employee involvement. This suggests a particular organisational weakness in this area and is an issue that was discussed more fully in the previous section (6.5) of this chapter. Analysis of the data spread by *hierarchy* using one-way ANOVA supports these observations, showing the same positive and negative response values across the organisation in relation to each statement, exhibiting no significant differences between the hierarchies. This confirms the strong and pervasive level of value congruence indicated by the descriptive statistics. Analysis of the statements by *function* also shows strong agreement between the functions with respect to statements a-h, further reinforcing the high level of congruence on these issues across the organisation.

This degree of congruence when the statements are compared according to the hierarchy and function variables is, however, unexpected as the analyses for the other survey variables showed significant differences between the groupings across a range of issues. The lack of any significant differences between the groups in relation to the value statements may be due to a degree of 'strategic responding' with employees giving (what they perceived to be) the 'right' answer. Non-significant findings may also be the result of some employees not being sufficiently knowledgeable of organisational activity in certain areas, to make a definitive judgement.

6.7.5 Value integration

The quantitative evidence presented in the preceding sections suggested that while significant variations exist between the personal and perceived corporate values of particular organisational hierarchies and functions, in many areas of the company there is a strong and positive environmental ethic. This evidence of integration and enthusiasm for the environment at a deeper level could also be detected from interview respondents. As one operations manager who had been working on environmental issues for several years commented:

> " I think the company spirit is that we have the environment very high in our minds and our targets and have had for a long time really..." Transcript # 17

Expression of achievements at a deeper level were also forthcoming from a member of the EMS team who noted that:

> "... I think we have won the hearts and minds of some very important people in the company." Transcript # 18

This is an interesting comment because it reflects how potentially controversial initiatives, such as environmental management, rely on key people in the organisation. The role of 'environmental champions' has now been well documented in the environmental literature (James, 1996) and is not discussed in detail here. What this respondent intimated was that it was not necessarily the most senior people who could make a difference. Rather it was those in middle management positions who had the power to integrate good ideas where appropriate. As this same manager then went on to say:

> "... we should be aiming for a company culture such that the management of the environment is the way that we do things every day ... it will be a long time though, I think..." Transcript # 18

However respondents were cognisant of the fact that the pace of integration and change would require disengaging from entrenched ways of working and acting, and that this process would demand considerable effort.

> "It is going to take a long time for people to be eating, drinking, breathing and living a different way of operating." Transcript # 18

Similarly as an operations manager reflected:

> " I would really like the area that I am responsible for to be beautifully tidy with everything running smoothly and the safety issues all dealt with ... but it is very difficult because it [environmental management] is a change of mindset for some of the guys who have worked here for years." Transcript # 10

This barrier of entrenched beliefs and an unwillingness to depart from tried and tested modes of working was not necessarily restricted to site-level workers as a scientist working on environmental issues indicated:

> " There is still very much a belief in the 'upper echelons' that environment equals cost and if you have to do something to improve the environment it will inevitably have a dis-benefit on the production process." Transcript # 7

These comments are illustrative of a widely held perception amongst respondents that not only was deep-seated attitudinal change hard to achieve but, that during the change process there was always a danger of superficial commitment. This, it was argued by

some, was potentially damaging in that it served to undermine and devalue the very real efforts being made at site level. As one senior operations manager and a member of the EMS team put it respectively:

> "The board have made all the right noises ... I always think that words are cheap; actions are what really count and we struggle at times to get the money [to deliver environmental improvements]." Transcript # 16

> "There is an awful lot of token effort put into the environment, the recognition of importance is lacking. There is still a fair amount of feeling that ISO 14001 is a badge that everyone should collect." Transcript # 7

These comments illustrate that, while efforts were being made to address some of the core cultural issues that have been argued as being necessary for environmental improvement, significant barriers remained. In particular, those working on environmental issues were becoming increasingly aware of how existing beliefs that did not encompass environmental concerns could impact progress. Perhaps most crucially, during the study, questions surrounding the motivation and commitment of senior managers remained.

6.7.6 Summary

This analysis examined personal and perceived corporate values with respect to four environmentally relevant factors (tip restoration, pipeline burst containment, employee safety and community relations). Personal and perceived corporate values were also examined with respect to five 'value' criteria (creativity, environment, product quality, people and profit). In each case I examined personal and perceived corporate values individually against hierarchy and functional groupings and then as a composite measure against these two groupings. Significant differences and the absence of differences were reported.

Personal values were revealed to vary significantly both vertically and horizontally across the organisation on a number of factors - community relations, pipeline burst containment, environment and profit. Employee perceptions of corporate values also differed significantly with respect to employee safety, community relations, pipeline burst containment, environmental and people. The analysis of the composite measure revealed significant differences on a number of factors, particularly employee safety, people, profit and creativity. The results also revealed a high level of value congruence

across six values statements and the organisation exhibited on average, positive environmental values. Although, as suggested, this level of agreement may have resulted from questions bias with respondents seeking to provide the 'correct' answer.

The qualitative evidence presented suggested that integrating environmental values remains a key challenge at all levels of the organisation, but that important steps had been achieved through the efforts of key staff, notably those on the EMS team.

6.8 Chapter Summary

This chapter has explored the first set of propositions developed and presented in chapter three. In order to do this I empirically investigated a selected set of 'resource characteristics' that have been conceptualised as underlying a pollution prevention capability. The data provided in relation to each characteristic was supported by an analytical presentation of additional contextual material. Resource characteristics were analysed according to themes as they emerged from the data and drew on both quantitative and qualitative data as appropriate.

Evidence of Total Quality practice was limited in this case with the company primarily focused on product quality and quality assurance. The relevance of these findings and the appropriateness of TQM practice more broadly, is considered further in chapter nine. With the value of teams in all organisational contexts increasingly recognised in this case, 'green teams' were being created through new initiatives driven at a strategic level. The findings suggested that the organisation's environmental management programme was accruing tangible benefits.

New organisational initiatives to involve employees in a programme of ESH training were used to engage staff and equip them with environmental responsibilities. However the success of these new measures was identifiably constrained by a number of factors including resource availability, selectivity, and the reluctance of workers to change existing practices. Explorations of environmental awareness showed a strong, shared appreciation of the company's impacts on physical environmental media. Employees appeared less aware of possible impacts in the broader socio-economic environment, which was manifest in a discernible variability of awareness both between and within organisational hierarchies.

The evidence presented pointed towards positive, shared environmental values both vertically and horizontally across the organisation. However significant differences emerged within and between the personal and perceived corporate values as expressed by employees with respect to a number of key factors including the environment. Explanations for these inconsistencies were posited in relation to the key areas of difference, and it was suggested that differences may be mediated by perceptions of organisational commitment and motivations.

These findings have implications for the relative strengths and weaknesses of these resources characteristics as applied to this case. Considered cumulatively, the evidence provides insights into the capacity of the case company to develop an environmentally (and possibly competitively) valuable capability in pollution prevention.

These key issues are considered in more detail in chapter nine, where I draw together the evidence presented in the three analysis chapters and make an assessment of the case findings from a pragmatic and a theoretical perspective.

Chapter Seven: Environmental Capability Explored: Clean Technology

7.1 Introduction

The chapter explores the second set of propositions developed in chapter three that aim to empirically investigate selected resource characteristics that have been conceptualised as underlying a clean technology capability. The three propositions are reiterated in Figure 7.1 below.

Resource Characteristic: Clean Technology
2a. A firm will be more likely to develop a clean technology capability when it can demonstrate the resource characteristic of cross-functional working.
2b. A firm will be more likely to develop a clean technology capability when it can demonstrate the resource characteristic of Design For the Environment and Life-Cycle Assessment.
2c. A firm will be more likely to develop a clean technology capability when it can demonstrate the resource characteristics of partnership and collaboration.

Figure 7.1: Research Propositions: Clean Technology Capability

The analysis presented in following sections draws largely from the qualitative element of the study. In addition, I make use of analyses conducted during the study that investigated the source of Life-Cycle Assessment (LCA) data requests and considered the impacts of these pressures on the company (discussed further in section 7.4). The data collection for the propositions investigated in this chapter is framed by an embedded case unit, the company's environmental product development activities. This meant that the evidence gathered focused on a specific area of research activity in the organisation rather than on research *per se*. I do, however, consider the nature of research at ECC more generally in order to provide important contextual details for the subsequent analysis.

The chapter therefore breaks down into four main sections. In the first section I provide key details to orientate the analysis, which relate to research activity in the company. In particular, I outline and give details of, the three main environmental projects that form the backdrop to the analysis.

In the following sections I explore in turn the resource characteristics developed in chapter three, providing an analysis of the characteristics through key themes as they emerged from the data. Each section is preceded by background contextual details that serve to assist the subsequent analysis. Factors that may influence the presence, absence and relative strengths of these characteristics, and therefore their potential contribution to the key resources and capabilities under investigation, are discussed through the emergent themes. Finally, I provide a chapter summary and synopsis that points to the key issues that will be discussed further in chapter nine.

7.2 Environmental Research Activity

7.2.1 Framing the analysis

In order to explore the three selected resource characteristics conceptualised as contributing to a clean technology capability, I examined the company's experiences with one major and two minor but related, environmental projects. During the study period each project was at a different stage of development. As a result the analysis presented adopts a reflective stance in considering how the development and commercialisation process was either helped or hindered by the relative establishment of the proposed resource characteristics. In particular, the analysis focuses on factors influencing the managerial aspects of development, rather than on the intrinsic technical detail of the projects themselves. However, in order to develop an appreciation of the products and processes involved I provide some basic, commercially available technical details as well as an outline of the genesis and development of each project. This information is summarised in the three boxed sections below (section, 7.2.2).

The focus of analysis for this set of propositions differs from the previous chapter six, in that the discussion centres primarily on the company's activities in the market environment.[1] Specifically, the environmental projects analysed all relate to the paper industry which, as I highlighted in chapter five (section 5.5.2), forms ECC's largest market with the greatest environmental opportunity. This chapter therefore draws its

[1] Analysis of the Life-Cycle Assessment and Design for the Environment characteristics also refer to activities in the production environment.

data from interviewees most closely associated with innovatory work. This includes research staff at the company's central research facility as well as technical and marketing personnel situated in the newly constructed business units in the UK and the USA.

In chapter five (section, 5.2.1), I indicated that ECC's research department has been well established since the 1930s. The company's research activity has over time, been credited with delivering key innovations that have maintained the firm's competitiveness in a growing and diversifying marketplace. For a large proportion of the company's formative years, the research department operated relatively independently from the main business at a different site from the headquartered activities. During this period, the basic nature and practice of research remained substantially unchanged focusing (in paper technology) on the development of mineral coatings and fillers

Although this physical separation from the production and administrative functions of the business continued with the move to a new site in 1990, the relocation marked the beginning of a number of gradual changes. In 1993 for example, a new 'Corporate Research Group' was formed which allowed some researchers to pursue new avenues of interest outside the company's core research activity (Transcript # 20).[2] More significantly, the new decade saw existing working practices change, with the focus and activities of research required to take account of new conditions both internal to the firm and externally in the market environment (Transcript # 24).

The most important recent change (described in chapter five, section 5.3.2) brought researchers closer to the business units with the financing of research work becoming more directly linked to demands and signals from the market. The net result of this new strategic direction was that researchers could no longer pursue projects:

- of intrinsic research interest;
- where the commercial case was not fully proven;

[2] This new independent group was given the opportunity to pursue new research which included the genesis of the environmental projects (Transcript # 23)

- or where the technologies and techniques involved were considered (at the time) to fall outside the company's core capabilities (Transcript # 22).[3]

Interest in, and the development of, environmentally-related research overlaps these changes which emerged during the 1990s and therefore the subsequent discussion of environmental work needs to be considered against this backdrop of changing research directions at the company.

7.2.2 Environmental Research at ECC

The emergence of environmental research at ECC can be traced back to the early 1990s. However, interviewes with several key senior personnel uncovered differing perceptions relating to 'how' and 'why' the company became engaged with environmental work (Transcript # 20, 22). This early confusion is significant and is reflected in an interrupted development path that has brought mixed fortunes for environmental projects.

There seemed to be general agreement amongst the people I spoke to who had been involved in environmental work, that the identification of possible opportunities and the first ideas for environmental projects, stemmed from a handful of research scientists. These key individuals had become aware of growing environmental issues while working closely in a technical capacity with a number of paper mills (*fn 16.4.77, 24.4.97*, Transcript # 22). In particular, several key issues had come to light:

- First, it was identified that key customers (paper companies) were beginning to ask ECC for life-cycle information. At the time this involved the production of basic data on energy and water usage. However, it was suggested by the paper companies, that more complex data could be required in the future, and that it would be incorporated into their buying criteria;[4]

[3] An addendum to this change in the research capacity of the company follows ECC's recent take over by the French company Imerys. Research personnel at the former ECC have now been reduced by two thirds and all research activity is strictly aligned to business units (Gore, 2000).

[4] Several managers noted subsequently that they doubted whether any paper company had actually made significant purchasing decisions on the basis of this information (Transcript # 20).

- Second, some of the larger Scandinavian mills began to report that managing the waste products of paper manufacture and recycling was becoming an intractable problem and that this issue would grow as environmental regulation and public pressure for cleaner production increased;

- Third, the mills expressed their concern that a proportion of this waste product included clay minerals that they were unable to recover using conventional mechanical means. Importantly for ECC, the mills were suggesting that the escalating costs of landfill could see a restriction on the mineral content of paper.

For the scientists involved in these discussions, the implications of reduced mineral sales presented a powerful argument that it could be beneficial for both their customers and future business, to research possible methods of mineral recovery from mill waste.

Against this background several researchers began to look at how existing technologies at ECC such as co-precipitation and calcination could be applied to the problems being experienced by the mills. From these early signals the scientists drew on existing expertise and formulated the core ideas that evolved into the rECClaim™, MAGIC and CCR projects (see Boxes 7.1–7.3 for project details).

Project: rECClaim™

"A unique patented process that facilitates the recovery of and re-use of certain paper mill wastes, thereby providing significant environmental value, reducing the cost of waste processing and disposal and providing materials for recycling." (ECC plc, 1995)

Concept:

ECC researchers identified that an understanding of recycling as a viable and commercial concept was becoming increasingly accepted in the paper industry. Demand for and production of recycled paper was growing in the early 1990s, while concurrently the costs of landfill were rising as space became more limited.

An assessment of mill wastes suggested that the raw materials lost from the paper making process were roughly equally divided between the pulp and mineral constituents. This material could be lost during the paper making process itself or through cleaning and de-inking operations. The value of the raw material lost and escalating landfill costs suggested that the recovery of this material would be both economically attractive and environmentally beneficial. These raw materials were generally not recovered because the fineness and darkness of the particles involved, made recovery and re-use too troublesome for the mills.

The rECClaim™ concept addressed these issues through a process that facilitated the recovery of fine particles in such a way that they could be reintroduced as a filler at the 'front end' of the paper making process. Essentially the research team developed a technique whereby the fine particles of the waste could be aggregated by growing precipitated calcium carbonate (PCC), in their presence. The technique itself involved some adjustment of the waste stream for solids content and temperature, a mixing process, followed by carbonation of the mixture to produce the precipitate that served to aggregate the particles.

As well as successfully recovering the waste material, the researchers found that the end product fulfilled a number of key criteria, essential for paper making (see chapter five, section 5.5.2). The filler was easily retained in the paper, scattered light effectively, was not detrimental to paper strength and improved paper opacity. The process also resulted in cleaner water that could be re-used in the paper mill.

Development:

rECClaim™ was developed through three stages. The first, laboratory stage, resulted in the successful manufacture of 1kg/ hour of product. The development of a self contained mobile plant allowed for piloting at prospective customers, and could generate 10kg/ hour of product. The third stage involved the building of mobile plant housed in two trailers. These trailers could be installed at a mill site and when running could deliver 250kg/hour of product, sufficient for a short mill trial.

By the end of 1995 the research team had completed several technically successful mill trials to prove the product and became actively engaged in seeking further customers for trial attempts. During the study period several further mill trials were completed. However, attempts to commercialise rECClaim™ continued with limited success. Possible future avenues for the project, included joint venturing and licensing to a competitor company.

(Sources: *fn 16.4.97; 20.4.97*; ECC plc, 1995; Transcripts # 22, 25,26)

Box 7.1: Environmental Projects: rECClaim™

Project: MAGIC

"A technique which allows the recovery of mineral pigments from de-inking sludges. The recovered pigment may be used either as a filler or in coating and has the potential to contribute towards waste minimisation in paper production." (Phipps et al, 1998)

Concept:

ECC research of paper making waste products identified that a large proportion of mineral could be lost during the de-inking process. De-inking occurs as part of the recycling process where paper is re-pulped, and results in a 'sludge' composed of minerals and organics. Analysis of 'sludges' showed the mineral content to be approximately 50%. Research suggested that landfill costs, either for the sludge itself or ashes derived from sludge incineration, were set to rise, with high costs concentrated in the Central European countries. Alternative disposal methods included using the sludge directly in construction (e.g. for brick and board making) and composting, or incinerating sludge and using the ash for cement or in road building.

ECC research identified that physical methods (e.g. flotation and washing) were unlikely to recover the mineral fraction and therefore drew on existing expertise to develop alternative methods. The technology created involved incinerating the sludges under closely controlled temperature conditions. Following a first incineration stage, which removed organic material, the remaining ash was subjected to a further calcination leaving clean pigments. This pigment could then (after passing through conventional mineral processing techniques) be applied as a filling or coating product. The resulting product was shown to have desirable light scattering properties and light absorption coefficients, with performance comparable to virgin minerals in filler and coating applications (specific properties depended on the sludge source).

Development:

The MAGIC process was successfully evaluated in the laboratory using de-inking sludges obtained from different customers. By 1996 the research team had begun to put together pilot scale equipment with a view to securing and running mill trials. At this point the process required a more comprehensive development of the key economic criteria including market research, production costs and the price of further technical development. Issues relating to scale-up had also not been resolved

During the study period attempts to commercialise MAGIC were limited. Some trialling with a French mill took place and presentations of technical papers outlining the processes were made at conferences. Researchers responded to queries from customers rather than actively pursuing new business.

(Sources: fn 16.4.97; 15.5.98, Transcript # 22; Phipps et al, 1998).

Box 7.2: Environmental Projects: MAGIC

Project: CCR

"A technique to recover the components of split coating colours, including soluble chemicals, which allows them to be blended with fresh colours and reused with no detrimental effects. The technology has the potential to make a significant contribution towards waste minimisation in paper production." (Phipps et al, 1998)

Concept:

ECC research of waste products in paper making identified that mills lost a large proportion of raw material when paper sheets broke, grades of coating were changed, or during washouts (when the paper machines are cleaned between runs). With losses frequently in excess of 15% the research team identified that recovery could be both economically and environmentally beneficial to mills. With low contamination levels (organics and fines) in the waste product, the main barrier to reuse was recognised as being large quantities of water. Investigations showed that some mills already used filtration and flocculation to recover solids but that these techniques generally did not produce a product that was suitable for reuse as a coating.

To address this problem the research team applied knowledge of evaporation techniques and developed a 'forced evaporation' process that subjected the wastes to temperatures of 50-60°C under reduced pressures (Phipps et al, 1998). The technique resulted in a high recovery level of the coating mineral and clean water as a by-product. In addition, the soluble compounds used in paper making such as dispersants, brightening agent and thickness could also be recovered.

Development:

The CCR technique was first evaluated at laboratory scale using formulations representative of different mills. Tests showed that the recovered product functioned as well as freshly mixed colour. Scale up to pilot level on a production sized coater (undertaken at ECC's technical Centre in Belgium) confirmed these results.

During the study, CCR did not progress beyond this pilot phase. Scientists suggested that questions still remained in relation to the potential market (quantities and dilution levels of mill waste streams) as well as energy sources to run the process.

(Sources: fn 16.4.97; Transcript # 24; Phipps et al, 1998).

Box 7.3: Environmental Projects: CCR

Reflections on the development period of the three projects suggested that they could be considered according a timeline that broke down into three main stages. The early 1990s saw the birth of these environmentally-inspired ideas. Potential avenues were explored by a small research group who, in addition to technical exploration, undertook several research and scoping studies.

An internal review of paper recycling identified that the recycling and regeneration of filler and coating pigments was indeed a major concern for paper customers. Additionally, it was detected that a key competitor had already embarked on both fibre and mineral recovery from mill waste, through a joint venture with a paper customer (Plasted, 1993). The report recommended that in the face of these pressures, ECC develop its own 'Environmental Profile' for customers. Significantly the author also pointed to the need for the company to develop a more proactive approach to monitoring and understanding how environmental pressures in the market might affect its own business.

A second study conducted by a small research team examined industrial environmental opportunities for ECC based on existing knowledge and technologies (*fn 16.4.97*). The team identified that clean technology would become increasingly important in the future industrial development of their main paper markets. However, they also noted that working towards clean technology involved progressive changes that included embracing recycling technologies. The team concluded that the company's established expertise could be best applied to the recycling of water and particles in water based industries.[5] As a volume producer of waste-water and particles, the paper industry fitted these main criteria supporting the initial directions taken by the environmental projects.

On the basis of this additional research and the early technical explorations made by the team, the work entered a second phase. During this period (circa 1994), most activity was focused on the rECClaim™ project and capital was made available to progress further mill trials, with a view towards the successful commercialisation of the project. However this capital injection did not come through conventional organisational channels, as a senior manager explained:

> "What happened was we had an R&D director at that time who had an extremely good personal relationship with the then CEO. So really rather than going through the conventional channels [for financing] he headed straight to the CEO and said, Wow this [rECClaim™] looks really good, why don't we do this." Transcript # 20

[5] ECC's expertise was considered to fall into five main areas: process engineering; colloid science; polymer science; process control and flow sheet design and optimisation.

With high profit forecasts and an enthusiastic injection of capital, the rECClaim™ project in particular, appeared to be an attractive new venture for the company (Transcript # 30). As a senior manager involved in the original sales and marketing for rECClaim™ put it:

> "The idea that you could package the rECClaim™ thing ... that did look attractive I must admit and that sort of started it off." Transcript #21

However, the third period in this timeline reflects changing fortunes for the projects. This phase, which coincided with the study period, reflects the stalled progress of the projects following (although not necessarily linked to) the departure of CEO Andrew Teare in 1996. Internal reorganisations witnessed a dispersal and reassignment of the researchers involved with environmental projects (Transcript # 30). Organisational changes, as highlighted above and previously, brought new strategic directions and priorities that effectively reduced the time and capital available to environmental work. As noted in Boxes 7.2 and 7.3, the MAGIC and CCR projects have undergone limited further development since this period.

This outline of the projects implies that much of the difficulty with environmental work emerged after 1996 when capital and human resources were withdrawn, in line with the revised company strategy. However, analysis of the evidence obtained, points to problems preceding this period that relate to a number of factors that I discuss with respect to the proposed resource characteristics in subsequent sections. Crucially though for what follows, it became evident when exploring the environmental projects with interviewees, that fundamental conceptions of the nature and value of this work had differed. These contrasting opinions appeared to have been in place from the outset and, it is suggested, remained largely unresolved. Both scientists and managers expressed a belief that environmental work provided significant opportunity for new profit sources through diversification (Transcript # 22,25). Other notably senior staff, however, perceived the environmental projects in an entirely different manner. As a senior manager explained:

> "My objective was ... not for it to be a business for ECC, the objective was to make the business of selling minerals to the paper industry sustainable. In effect for me it was going to be a service to the industry. So if we were running these processes like

> MAGIC and rECClaim™ at zero profit I felt that would be acceptable." Transcript #20

This mismatch of expectations and goals provides an important backdrop to the analyses that follow, which expands further on how divisions have impacted the development of the key resource characteristics.

7.2.3 Summary

In this section I have outlined some of the key contextual and chronological details that have framed the development of environmental research at ECC. I particular, I have drawn attention to the impacts of organisational change on both mainstream research and the new environmental projects. The boxed outlines of each environmental project serve to highlight key conceptual and developmental details, and assist in an understanding of the nature of environmental research conducted at the company. Each project has been influenced by a loosely defined timeline that is divided by organisational changes as they impacted these projects.

The discussion points to a fragmented path for project development that I imply is influenced by varied conceptions of the projects that surfaced during data collection. This variability of understanding is an illustrative theme that is reflected in the subsequent discussion of the proposed resource characteristics.

7.3 Cross-Functional Working

7.3.1 Background

ECC's organisational structure was in a state of flux during the study period.[6] However, for the purposes of this discussion it is important to observe that tradition and historical evolution had resulted in the company being organised along functional lines. This strong company history, explored in chapter five, is one of bureaucracy, old divisions and hierarchies that relate both to salary and a perceived position in the organisational 'pecking' order (Sims et al, 1993).

[6]So much so that organisational charts became redundant almost on a monthly basis.

As I noted above, the company's research and development (R&D) function had been physically divided from the rest of the organisation throughout the company's history. During the study it became apparent that this physical separation was compounded by a perceived intellectual gap that set research staff apart. Research, it appeared, was regarded as the preserve of the few: "... only people with PhDs get in there..." (*fn 25.2.99*). On several occasions, interviewees referred to a 'snobbery' and 'superiority' of research staff that they perceived as maintaining barriers between the functions, (*fn 16.6.99*) This independence had, even with the most recent organisational changes, remained relatively untouched. Several scientists remarked that they had 'barely seen' the McKinsey consultants who had instigated some of the more recent changes affecting large parts of the company (Transcript # 23). Interestingly, however, within the company's research community itself there appeared to be far less division, with UK and USA staff interacting on a regular and consistent basis.

I have already suggested in chapter five that the legacy of past working practices and affiliations have played a key role in determining how issues are framed, and projects are developed, in this case. In this section I argue that these factors are pivotal and characterise emergent themes that serve to either support or undermine the resource characteristics.

7.3.2 R&D/ Marketing Divisions

Towards the end of the study period ECC were beginning to conceptualise R&D and its relationship with the rest of the firm from a new perspective (discussed in more detail in section 7.3.4). However, the period that framed the development of environmental projects was largely founded on pre-existing structures. As a result, existing modes of working influenced the way these projects developed. Of particular note was a pervasive *'us and them'* mentality that existed between the R&D function and the business unit staff involved in sales and marketing.

Several scientists believed strongly that their own role lay in the technical development of a project, but not beyond:

> "So we've got a technically viable process [CCR], we think it is commercially viable in the right mills, but we have to decide whether there is business there, so it has been handed over to the paper marketing group." Transcript # 24

> " ... oh that [commercialisation for MAGIC] has to be thrown out to the business units..." Transcript # 27

> "... what they [marketing] have to do is decide if there is potential business there [for CCR] who the best possible customers might be, who we have a good relationship with..." Transcript # 35

This delineation of responsibility was sustained, even in situations where it was possible that a more progressive overlap with compatible competencies may have been beneficial to the development of the project.

> "One bloke was actually seconded to help with the scale up of the [rECClaim™] process because we had to build things that go in trailers and R&D people don't do that." Transcript # 22

These comments indicate that scientists had formed a view of their role in the development process that focused primarily on the scientific and technical elements of the projects. While clear in expressing where they felt their responsibilities lay with regard to the commercialisation of the projects, scientists seemed less comfortable about actually relinquishing ownership of the research projects to the marketing staff.

> "... the man who was running the project [rECClaim™] left and was replaced but he [the replacement] was not an R&D man..." Transcript # 22

> " It's the marketing guys, they are really not marketeers, they are sales men and are ultimately just interested in the tonnes [of clay product] that can sell this week. The thought of a new concept was totally alien to them. We had the technology but we didn't have the marketing." Transcript # 22

Several scientists I spoke to were strong in their criticism of the marketing expertise in the company (*fn 14.6.99*). Marketing they suggested, had never been an organisational strength as the company's historically large market share had militated against the need for aggressive or innovative marketing techniques. As a result most of the early market research work and forecasting for the environmental projects was in fact conducted by R&D staff (even though as noted above, commercialisation itself was passed to the business units). Interestingly, this implied ineptitude continued following the introduction of stage gating, to the development of R&D projects.[7]

[7] Stage gating was adopted by ECC towards the end of the study period. Stage gating is essentially a process management methodology applied to the innovation process. It divides the innovation process into a predetermined set of stages,

> "... that [stage gating] only works if everyone uses it and the tough bit is the market bit saying , 'what is that market' and that bit just doesn't get done..." Transcript # 32

The position adopted by the R&D staff and their proprietorial nature towards research projects was felt to be equally inhibiting by those staff who had been charged with the commercialisation of these new environmental projects. In particular these interviewees noted how the lack of any overlap between the two functions made learning about the projects and formulating a sales approach, extremely difficult. In conversation with one marketing manager it was indicated that following the 'hand over' of rECClaim™, marketing were required to recalculate previous forecasts of the economic value of the project to mills (*fn 20.4.97*). This was because they, (marketing) had identified that the variation in mill circumstances meant that the viability of the process needed to be evaluated on an individual basis (Transcript # 26). He pointed out that with no framework in place to integrate these the two functions, their understanding of, and ability to market the project had been severely curtailed (*fn 20.4.97*). These deficiencies were expressed by a second manager who noted that:

> "There was a period when it [rECClaim™] was still part of R&D, they were controlling it and we [the paper group] were just learning about it ... the phrase they used was 'once we run the mill trial and prove it technically then it is yours to sell.'
>
> They [R&D] knew everything about precipitation but nothing about its [rECClaim's™] application on a paper machine, particularly in terms of long term runnability and making it commercially viable." Transcript # 26

That the approach adopted for the environmental projects did not address in detail the commercialisation element of the innovation process, was exemplified by the comment of a US based scientist who had inherited a more recent environmental project from the UK (outlined in Box 7.4).

> "The problem was initially that marketing had the project [Surround] and there was oodles of technical information that was unknown. All the requests for technical information would come as a result of failures in the field and then it would come back to us and we were more or less like technicians, we were just feeding information into a hole." Transcript # 28

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themselves composed of a group of parallel stages. The entrance to each stage is a gate, these control the process much like quality control checkpoints (Cooper, 1990).

This is a key comment as it embraces several of the issues outlined above. First, because there had been little overlap between the technical development of the project in the laboratory and it application in the mill, those trying to market the project were faced with technical difficulties that required ongoing referral back to the scientists. Second, in expressing his frustration, this scientist points implicitly both to the inadequacy of the development process, and his feelings about being reduced to the status of technician. A role that was perhaps, not the best use of time or appropriate, for someone of his expertise.

Project Brief: Surround

ECC developed Surround using the CheMin approach which involves applying chemical and mineral expertise jointly to find solutions for the paper industry (discussed further in section 7.3.4). Scientists identified that paper mills consistently have problems with what are termed 'stickies'. These particles may result from the resin inherent in pulp obtained from trees, or from adhesive material that occurs in pulp derived from recycled material. These 'stickies' act to 'clog up' paper machines, causing problems in paper production. Conventional solutions involve adding talc to the pulp, but this method can introduce impurities into the system.

ECC's solution was to chemically modify clay particles so they could attach themselves to the 'sticky' until they completely 'surround' it. The result is a particle that can move through the paper manufacture process and become part of the paper product without introducing impurities.
(Sources: ECC, 1999; Transcript # 28)

Box 7.4: Environmental Projects: Surround

With scientists from the American and UK arms of the company working together on projects, it was not unexpected that some of the negative aspects of 'divided' working were translated in an American context. As one US-based scientist observed:

> " The product [Surround] was actually developed in St Austell and then a strange thing happened in that it went directly from there to marketing. So we got involved at the back end of the product and the last couple of years I've been fighting our lack of knowledge of the product." Transcript # 28

It was discernible that this separate development activity caused some friction between the US and UK-based scientists. This was particularly the case where the US research

team could demonstrate an arguably more integrated and progressive research approach, which is discussed in section 7.3.4 (*fn 14.6.99*). When exploring these tensions with a US-based scientist who had worked on rECClaim™ in the United States he explained that:

> "When they [UK R&D] do a project, they look at every angle. With the US we've got a lot of things that still aren't right but we try and make it work and commercialised. I'm not trying to say which is right or wrong but, they [UK R&D] will look at the way we do things and say that we are sloppy when things go wrong... One of the things the UK people don't understand is how short a time frame we have over here... In the US they want results now, even if the results are not picture perfect." Transcript # 33

On the basis of evidence presented in this section, it is suggested that US project development (including those they had acquired from the UK) had adopted a greater overlap between the development and commercialisation functions. This was because in their experience the US paper market would lose interest if projects did not deliver rapidly. A shorter development cycle with some imperfections was considered preferable to a 'perfect product' that had missed the market window of opportunity.

It is argued these highlighted divisions between R&D and marketing, significantly affected the development of the environmental projects. Even in the US where the functions were more integrated, project commercialisation was adversely impacted when scientists inherited work that originated in the UK. The discussion of these experiences and the opportunity to reflect on these functional divisions, led some interviewees to express how a large proportion of their work on the environmental projects had been *disjointed.*

> "If you go back to when these [environmental] projects started, there was R&D distribution and marketing and they weren't necessarily all pulling in the same direction which was a real problem." Transcript # 26

> "We've [now] got the manufacturing, product supply and the business units and that is still a bit separate." Transcript # 32

> "If you are going to make a technology like that [rECClaim™] work it has to be R&D working with marketing and the customer to justify it going forward." Transcript # 30

Interesting, therefore, was the observation that in spite of this new understanding, brought largely by the experiences with the rECClaim™ project, environmental projects

were continuing along a disjointed path. With respect to the MAGIC project a senior scientist noted how:

> "It has been very much the customer and us [R&D]. We've done all the costings and presented them to the customer... We always try to get marketing involved and they come along to a lot of the meetings but they have always been rather ambivalent about it [MAGIC]. I think their attitude is well, if this is what they [the customer] wants then we are not going to obstruct them [R&D]." Transcript # 23

When probed further, it emerged that this disjointed working and general lack of integration stemmed from *conflicting expectations* of what the environmental research in general and these products in particular, were designed to achieve. As suggested in section 7.2.2, these issues were not addressed at the time and continued to be a source of conflict and misunderstanding between the two functions. This theme is illustrated through comments made by senior managers from both perspectives:

> "I think what we as R&D guys thought we were doing was providing the technology to allow the company to sell itself as an environmental leader in the world, but I don't think the marketing guys ever understood that. I'm certain they didn't, I don't think they still do." Transcript # 22

The marketing staff had arguably less ambitious goals for the projects based on their experiences following the hand over:

> " It [the rECClaim™ project] was sold to us internally on the basis that the mills would be 'biting our arms off' to get at the plant. Now that certainly never happened." Transcript # 26

> "The two sides never really came together and it [rECClaim™] didn't actually hang together the way that the research people indicated." Transcript # 25

> " The research view was one of a huge moneymaking opportunity. The way I would view it [in marketing] was that these things [environmental projects] support our ability to sell other products." Transcript # 30

What we see through this analysis is that two of the key functional elements in the innovation process, R&D and marketing, failed to work in an integrated manner. These divisions were in this case, characterised by an *'us and them'* mentality that resulted in *disjointed working*. This was further compounded by conflicting expectations with respect to the goals of the environmental research and the value of the projects to the company.

7.3.3 Reliance on key individuals

The lack of integration uncovered in the preceding section meant that work on the environmental projects tended to be conducted by small, relatively exclusive groups of individuals. Studies of technological innovation have cumulatively identified that the innovation process relies heavily on identified key individuals, for example the product champion and that as such it is essentially a people process, as described by Trott, (1998). As part of this process the individuals involved in development activity accumulate knowledge. This knowledge is frequently tacit as classified by Nonaka (1991), and although shared can be unevenly distributed between the group members.

At ECC, I have suggested that environmental research was sustained by a relatively small group of scientists. As such, this group was vulnerable to change and therefore significantly impacted as organisational restructuring began to take effect. The loss of a key member from the rECClaim™ project had a measurable impact on its development. As a senior manager and a senior scientist who had both worked on the rECClaim™ project from the outset observed respectively:

> "There was a stumble for about six months which was really bad because it was caused entirely by personnel changes." Transcript # 22

> "The problem was that nobody has all of it [an understanding of the rECClaim™ process] in their heads. The ones who really had everything in their heads were [named scientists] who were then working here [in the US]." Transcript # 31

In a specific reference to the value of this tacit knowledge, he commented further that:

> "All the trials [for rECClaim™] were documented. But whether people actually read them I don't know. There are of course special skills about this kind of process, and the work that we did, that you really can't extract from pieces of paper." Transcript # 31

On reflection, several senior staff commented that allowing the fragmentation of the project teams had adversely impacted the work. In particular it was recognised that you needed a spread of knowledge that ran consistently throughout the project beyond the technical phase.

> " I guess what I'm trying to say is that 'people' made a miscalculation that, because we had done a mill trial, everybody understood the stuff [rECClaim™]." Transcript # 22

Evidence from the interviews suggested that the accumulated knowledge for environmental work, as well as the key technical details, resided in a handful of individuals. When scientists were re-deployed or left the company, the progression of project work was dramatically curtailed until new team members had had time to learn about the processes. This situation was exacerbated by the fact that no apparent mechanism existed to share or disseminate tacit knowledge.

7.3.4 Incremental change – towards integration

Of the organisational changes underway during the study period, two initiatives were notable for their impact on research staff. The US side of the business saw the introduction of the CheMin approach. The rationale behind CheMin was that significant synergies existed between the chemical and minerals elements of the business. The purchase of Calgon (discussed in chapter five, section 5.3.1) with its large mill based sales force, meant that ECC had closer access to the workings of the paper business. With CheMin they embarked on an integrated service package to customers that required the research and technical elements of the business to be more interdisciplinary. The environmental project 'Surround' emerged as a commercially viable proposition through the efforts of the CheMin approach. One scientist working on this project commented on both the advantages and the challenges of this new approach:

> "In the last reorganisation they [ECC management] got some mineral people in a group with some chemical people and the focus on project working and cross-functional teams has really helped us get this project [Surround] off the ground.
>
> It has been a struggle though [to manage the interface between the functions] but I think we have done it by working more closely together with technical and marketing, targeting specific accounts and not biting off more than we can chew." Transcript # 28

Similarly a US based technical specialist working on a range of new biocide products with environmental applications was keen to stress the progressive nature of new working practices.

> "We need to do that [cross-functional working] even more ... I work closely with a colleague in Atlanta on mill closure issues and his complementary work is going to

> bring a lot of credibility to anything we bring to the mills in terms of problem solving." Transcript # 29[8]

A senior manager confirmed this positive feedback on new working practices while sounding a note of caution.

> "We've done a lot of interdisciplinary working now and it is without a doubt pretty powerful stuff. We still don't do enough of it though and there is still a degree of 'silo mentality' out there." Transcript # 32

On the European side, the realignment with the business units had meant a move away from the technology push of past R&D towards greater market pull, with the financing of any new research project dependent on business unit support. Both R&D and marketing staff were beginning to reflect on their experiences of these changes during the study period. The thoughts of three interviewees working from different perspectives are reflected below. While these comments point to an awareness of the benefits of more integrated working, some of the tensions and difficulties expressed in the analysis above appear to remain.

> "There is now much more discussion about where the R&D effort should be put so we get a chance, an input, the business units do. Whereas before what R&D did was nothing to do with us at all." Transcript # 26 *(Marketing Manager)*

> "Some of the ones who have worked for the company for a long time find it hard to adjust to the new ways of doing things ... but it is clear that having cross-functional people on account teams ... you are getting a more unified approach to problem solving." Transcript # 22 *(Senior Manager)*

> " Things are changing now, I think that the idea of technical road mapping, that you have marketing people involved before you do any of these [environmental] projects ... that will be a change for us. Because we usually say we have the ability to make that and then say 'OK now we have made it you [marketing] go and sell it'... and that has worked quite well." Transcript # 24 *(Senior Scientist)*

These reflections from both the US and UK sides of the business suggest that some of the difficulties associated with the development and commercialisation of the environmental projects had resulted in lessons being learned. Evidence of the benefits of more integrated working was starting to emerge towards the end of the study period although the original environmental projects had largely failed to benefit. It is, however,

[8] Mill closure is a situation where paper mills aim to contain all waste products and emissions within the facility boundary in order to achieve zero emissions status. As part of the process the mill must reuse its waste products and therefore can encounter a range of issues for example, with organics and sticky contamination of water.

suggested that in the face of these new changes there remained some reluctance to depart from established practices.

7.3.5 Summary

In this section I have presented evidence which points to the ability of the company to work across functions being hampered by divisions. The analysis suggested that the observed divisions between the marketing and R&D functions stemmed from historical structures and cultural allegiances. When viewed from the perspective of environmental project development, this division was characterised by three emergent themes - an 'us and them' mentality between the functions, disjointed working and underlying conflicting expectations of what the projects concerned could deliver.

As a result of these divisions there was no integrated structure to support project development beyond the technical stages. When key staff members left the project, valuable tacit knowledge was also lost and environmental project development stalled. With the introduction of new management practices the value of a more integrated approach was beginning to emerge, according to the reflections of interviewees. However, the benefits achieved were ostensibly too late for the environmental projects initiated prior to these new organisational developments.

7.4 Design for the Environment and Life-Cycle Assessment

7.4.1 Background

The evidence presented in this section derives from the study's two embedded units as the proposed resource characteristic of Design For the Environment (DFE) and Life-Cycle Assessment (LCA) is considered to span both elements. Specifically this resource characteristic is assessed, by examining its two components individually. Therefore, evidence of LCA work draws from the production environment while DFE practices are considered with respect to the production environment and the environmental research projects.

I have shown in chapter five (section 5.2.2) that ECC have a track record of developing technologies that improve the efficiency of clay mineral recovery. In particular, developments in flotation, blending and drying of the clay product were highlighted.

Other equipment improvements, also introduced for efficiency and compliance reasons, such as combined heat and power plants (CHP) and effluent treatment facilities, have additionally brought some environmental benefits. However, exploration of the case material suggests that historically less effort has been directed at examining how existing processes and practices in the production and research environments could be modified or superseded, specifically in order to become more environmentally proficient. Some changes are evident and examples of these are discussed in the next two sections. Before going on to explore these changes, it is worthwhile reflecting briefly on one of the key facets of mining that influences perceptions of the need to change, and that may have militated against developments in this area at an earlier date.

Mining and minerals extraction has generally been classified by environmental texts as a 'high impact' or 'dirty and damaging' industrial activity (Hutchinson, 1996). Those working in these industries are particularly aware of these perceptions, more so when operations occur in close proximity to resident populations (Transcript # 20). With environmental impacts being generated on a large scale, most companies have typically focused their attentions on the obvious (frequently visual) signs of environmental damage. ECC's stance is no exception to this, with most effort consistently directed towards remediating the company's impact on the surrounding landscape. Dealing with this issue had demanded a high degree of planning and survey knowledge, rather than technological insight. With attention directed at this level, less time has typically been apportioned to considering the environmental impacts of the production process at a micro scale, where opportunities for process and technological change may exist.

The emergence of a more detailed approach to examining environmental impact, witnessed through LCA and DFE techniques reflects both the shifting balance of external pressures, and the new ways in which the company perceives its environmental impacts internally. The company's engagement with these more detailed approaches is explored further below.

7.4.2 Engaging with LCA

In developing the research propositions in chapter three (section 3.4.2), I identified the value of LCA in terms of an information gathering exercise. I also drew attention to the fact the while LCA theoretically incorporates four phases (goal definition, inventory analysis, impact assessment and improvement), most LCA practice to date has focused

on the first two stages. Work in this case is therefore also considered in the light of these more restricted criteria.

ECC first became aware of a demand for LCA type data in the early 1990s when several of the company's key Scandinavian paper customers began to request more detailed information relating to raw material consumption and emissions from the company's production routes (*fn 10.12.96*). As noted in chapter six (section 6.2.1) with no formal environmental management function in place, the collation and provision of data fell to the technical services division. Discussions with the manager involved indicated that requests varied in the level of detail required, but that all tended to be product specific (*fn 21.4.97*). To answer these queries this manager undertook the first attempts at gathering LCA specific data using an inventory approach, drawing the boundary for analysis around the production site.[9] Using a simple inventory stage schematic shown below in Figure 7.2, calculations were made of the raw material, energy and chemical inputs to the system, and the emissions to air, land and water.

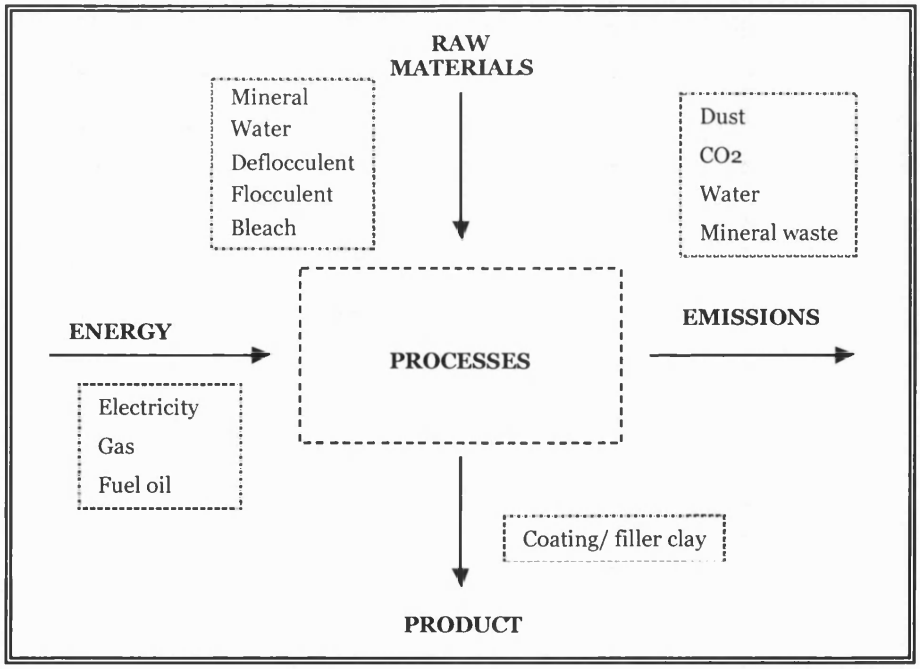

Figure 7.2: Life-Cycle Inventory Schematic (adapted from Clift and Longley, 1996).

[9] This form of site-specific impact analysis is the most well developed aspect of LCA. However this limited approach cannot represent total environmental load. A full LCA attempts to take account of 'upstream' and 'downstream' environmental effects as well as those directly associated with manufacture (Clift and Longley, 1996).

In gathering the data, the manager concerned was presented with a number of difficulties. With no measures in place to assess the volume of water usage or throughput, average figures were used. Energy and chemical calculations were based on budget figures, and where emissions figures were unavailable, discharges were based on average figures or educated assumptions based on knowledge of the processes.

The limitations of these calculations meant that this manager was sceptical as to the value of this data-gathering exercise. In his opinion, the customers he spoke to appeared to have a limited understanding of the complexities of the clay mining process, and would therefore have difficulties interpreting the data. Further, the site-specific issues, which could not be embraced in information provision of this sort, could strongly influence any meaningful comparisons with other product suppliers (*fn 19.12.96*).

With limited resources available to pursue a more detailed information gathering exercise, the company continued to response to customer requests on an *ad hoc* basis using this data. To obtain a more thorough gauge of the trends and depth of customer requests in this area, I conducted an investigation of questionnaires received by the company over a seven-year period (1991-1997). A summary of this analysis is presented in Box 7.5.

LCA Questionnaire Analysis

Approach

The questionnaires reviewed spanned the period 1991-1997 and were assessed to determine the level and scope of detail demanded by customers. The range of issues identified across the entire data set were grouped into generic categories, with requests reviewed against this inclusive list (sub-categories are not included here for brevity). The generic categories were:

- raw materials;
- energy consumption;
- total annual production,
- energy production (company's own source);
- water consumption;
- cleaning by solvents;
- transportation;

Box 7.5: cont.

- atmospheric emissions;
- effluents/ discharges to water;
- solid wastes.

The production of a data sheet for all entries allowed comparisons to made between company and sector requests.

Discussion

Most companies introduced their questionnaires with a brief statement of intent. Objectives included the need to determine upstream environmental impacts, or the life-cycle based environmental loads of their suppliers. Requests across the data set appeared to be motivated by three broad areas:

- Life-cycle studies conducted by individual companies who had extended their scope upstream to include ECC's operations;
- Companies responding to requests from further down the supply chain for product-specific information;
- Independent life-cycle studies being completed by consultancies who had identified areas within the product life-cycle requiring further information.

With few exceptions and variation in detail, all companies could be identified as seeking information in the categories of raw material inputs, energy consumption (for production and transportation); atmospheric emissions; water-borne emissions and solid wastes. The questionnaires not encompassing the full range of categories, focused on specific areas such as transport and toxicity issues. This suggested that (the paper mills) in this instance had already made some judgements regarding the most important impacts of mineral use when considered in the context of their own operational activities.

The majority of questionnaires concentrated on constructing mass and energy balances of products produced by ECC. This suggested that the customers concerned were primarily attempting to quantify the *environmental aspects** of ECC's operations. This is equivalent to the life-cycle inventory (LCI) stage of LCA. In some instances analysis identified questionnaires as seeking additional information on effect *classification** and *characterisation**. That is, customers were looking to determine a cause and effect relationship between ECC's emissions and the associated environmental effects. In these instances, requests included Material Data Safety Sheet Information and could be most closely aligned to the second, more advance phase of LCA - impact assessment. Impact assessment seeks to aggregate the complex LCI data into a

Box 7.5: cont.

small number of impact categories: environmental or ecosystem quality; quality of life (including human health); natural resources utilisation and social welfare (SustainAbility, 1993).

Inferences

The sample questionnaires spanned a seven-year period and it is suggested that the complexity and detail of these request was increasing gradually during this time. While requiring detailed information specific to ECC's product and processes, the information requested could not necessarily facilitate comparisons of ECC's environmental performance against competitors. More specifically, the environmental implications of any given emission would need to be assessed on a site-specific basis and as such customers could only make relatively generic evaluations. The provision of LCI data would mean that comparisons would be limited and at best customers could perhaps draw some general conclusions relating for example, to the contribution of; carbon dioxide emissions to global warming, or NOX and SOX gases to acid rain generation.

Summary

The sample reflected observations in the literature, that the bulk of LCA activity is concentrated on preparing LCIs. This would allow customers to make very basic quantitative comparisons, but the evidence suggested that some were prepared to carry out the more detailed improvements assessments on the basis of this LCI data.

Glossary

* *environmental aspect*: defined in the ISO 14000 series as an element of an organisation's activities products or services that can interact with the environment.

* *classification:* the process of assignment and initial aggregation of LCI data into relatively homogenous groups.

**characterisation:* the process of identifying impacts of concern and selecting actual or surrogate characteristics to describe impacts.

(Source: Thomas, 1998)

Box 7.5: Analysis of LCA Customers Requests 1991-1997

While this analysis suggested that there were some clear trends toward increasing and more detailed LCA driven requests, the response at ECC was not commensurate. At this time those working in this area felt that, while the requests were growing, there was

little if any evidence that customers were actually making meaningful purchasing decisions on the basis of information sent by ECC (*fn 21.4.97*).

Subsequent internal reorganisations saw the LCA work being reassigned to the research department. At this point (*circa* end of 1997), a project to gather more detailed LCI data across the production function with respect to each specific product, was initiated. However, with continuing reorganisations the project was given low priority and limited resources and as a result the work took over two years to complete.

Nevertheless the outcome of this exercise was the production of a significantly more comprehensive and detailed outline of LCI data (using a schematic as illustrated in Figure 7.2) for each of the company's hydrous and calcined clay products (44 product lines in all, Imerys, 2000). A review of this work with the principal researcher involved suggested that, in spite of the advances made, significant grey areas in the company's ability to supply accurate LCI data remained (*fn 7.12.00*). He highlighted several areas of concern:

- Hydraulic mining utilises large quantities of water, of which a significant proportion is abstracted from ground water. Investigation identified that no accurate figures exist for these abstraction rates. This required a 'worst case scenario' to be included in the LCI figures, showing disproportionately high consumption figures:

- Chemical inputs can be accurately identified through budget calculations. However a feature of clay processing is that production routes change on daily basis, meaning that any figures provided are at best a 'snap shot' of chemical usage at any one time;

- Electricity requirements for china clay processing are high. However for the 500 or more motors in operation on any one site, there may only be three meters at which to take accurate readings. As a result, calculating the energy requirements of different clay grades is necessarily based on a number of assumptions (Imerys, 2000).

What stands out in this analysis of company LCA work, is that while the data provision had become more detailed it had not moved the information gathering stage of LCI. More significantly, there was no evidence during the study or subsequently, that any of the information obtained would be used to evaluate or improve the environmental performance of the processes involved (*fn 7.12.00*).

Ironically the company had demonstrated significant improvements in environmental performance in the areas covered by the LCI work but they had been achieved through its ongoing continuous performance improvement (CPI) initiative (discussed further in chapter eight section, 8.2.1). Designed as a cost reduction exercise, this management initiative used 'life-cycle cost' techniques to address inefficiencies in the company's various production systems. In particular, the teams that investigated cost reductions in the areas of energy management and water use identified savings that also brought environmental benefits. This included the more careful metering of water use and conservation measures, as well as tightening controls and modifying the energy requirements of process equipment (ECC, 1998; 1999).

The evidence suggests that while LCI data had become more comprehensively developed during the study period, the rationale behind the data gathering exercise itself has been largely disregarded. The company has been driven by the need to provide information to its more progressive and environmentally aware paper customers, but the opportunities to use LCA techniques internally for management purposes have not been pursued. As such the LCI work is an outlier of environmental practice in the company. Specifically, their were no obvious signs that the information obtained through LCI would be integrated into environmental management practices, or that the principles of assessing 'environmental efficiency' in this way would be applied in order to seek environmental improvements for the company's benefit (*fn 7.12.00*).

7.4.3 DFE in the Production Environment: Limitations and Opportunities

The limited use of LCA as a progressive management tool, suggested that the application of DFE techniques could also be restricted. However, the data gathered through the cost reduction initiatives had encouraged a number of managers to consider the areas where their production equipment could be improved with concomitant environmental benefits. To this end several expressed their frustration that high costs and budget restrictions prevented them from installing new equipment.

> " I would like to be able to replace the pipelines on my patch, install safe systems to detect leaks, and install catch systems so if the worst came to the worst [the pipeline broke] we could catch it, but we are talking millions of pounds just for a new pipeline. So to put in a new pipeline with the ultimate safe systems would add another 20-30% to that cost. So we are not going to do that." Transcript # 10.

> "I've some very old [clay] dryers in my area. They are over 40 years old and you know I do find it very worrying that we are going to be able to continue to meet legislation and current expectations with very old equipment. I mean I'm a trained engineer and if I had a 40 year old car out there I would not be expecting it to meet today's emission standards!" Transcript # 11

Implicit in these comments is the difficulty of applying more stringent criteria brought by new standards and expectations to existing technologies. However, a feature of this organisation observed during the study period and implied in the case context analysis in chapter five, is the intrinsic ability to innovate where opportunity exists. It was therefore possible to identify through the course of the study, several illustrative examples of incremental attempts at improvements brought by the more progressive managers. In particular, these managers were sourcing new equipment and commissioning new designs for existing equipment that included environmental design criteria. A key illustration was provided by the company's efforts at a new calcium carbonate plant constructed in Sweden. As the engineering manager involved in this work explained:

> " We started from a position where we not going to discharge any effluent, so zero emissions. And it was like, 'hang on guys we don't know how to do that'. So we had to talk them [the Swedish-based staff] through [our] logic of that not being possible and they talked us through the logic of minimising it. And it made us push technology and process to be able to minimise it [effluent] and the generation of waste." Transcript # 13

As this manager then reflected, although the company had developed the 'know how' for a cleaner production process, this would have been extremely difficult to achieve at the company's Cornish operations because of the legacy of existing equipment.

> " Here in CCDC [China Clay Devon and Cornwall] it would cost millions and millions of bucks to do that, especially the way the operations have grown up over the years. Because we looked at their process from the point of view that we had to try and get to zero, the whole process was reviewed and changed to try and get to that position. Here you would put effluent treatment in but you would be treating a heck of a lot more material than you would over there because of the way we designed the process. Effluent treatment was not an issue here ten years ago." Transcript # 13

A further example of progressive design aimed at incorporating environmental criteria, was presented by a manager working at the company's ports operations. He was concerned with the potential for dust blow that, in his experience, frequently occurred as clay was loaded by chute onto the ships.[10] Growing public complaints about dust had provided the stimulus to address this ongoing problem. He had therefore commissioned a team to design a more effective chute. As he went on to outline:

> "What we are doing [to address the dust issue] is modifying our collectors, our ship loaders I should say. What we have in mind is called a cascade chute. Our normal chutes are like big elephant trunks with buckets in them and if you discharge at the top the clay reaches maximum velocity at the bottom. Although we have a big shroud, you are bound to have some coming out. What the cascade chute does ... it is made differently but basically you have buckets on their side [drew diagram] so when the clay reaches the bottom it is at a very low velocity. So we have a team at the moment working on the design criteria to fit these to our existing ship loaders. At Par [port] we have mobile portable pieces of kit and we need to modify them, so that is another thing we are looking at at the moment. We are talking a considerable amount of money, one of these chutes is roughly £80,000 and we are looking at four at least." Transcript # 17

These examples pointed to the fact that in some areas, managers were beginning to consider environmental concerns as part of their design criteria. However, these efforts were clearly limited and it is suggested were dependent in part, on the motivations and interests of the individual managers concerned. Additionally the ability to apply new design criteria incorporating environmental credentials was fundamentally constrained by the requirement to work with existing, older equipment as well as financial constraints.

7.4.4 Conceptual Application of DFE

In contrast to the retrospective application of DFE criteria in the production environment, the environmental projects exemplified the use of DFE principles from the outset. In section 7.2.2 of this chapter, I showed how the environmental research projects were founded on an analysis which identified that ECC's main market was beginning to adopt cleaner technologies. In particular, mills were becoming increasingly conscious of the need to embrace cleaner production techniques. Although subject to a range of pressures (described in chapter five, section 5.5.2) mills were also becoming

[10] Dust was highlighted in chapter five, Table 5.3, as one of the major environmental impacts on air quality associated with ECC's operations.

aware that some sources were challenging whether the resource depletion and environmental load associated with paper recycling could actually offset any benefits obtained (Virtanen and Nilsson, 1993). Therefore any technology capable of reducing the environmental burden of virgin production and recycling process such as de-inking, would benefit a mill's environmental profile.

Each ECC technology outlined in Boxes 7.1-7.3 implicitly seeks to reuse raw materials that would otherwise be lost from the system as illustrated in an industrial ecology model of material use, Figure 7.3.

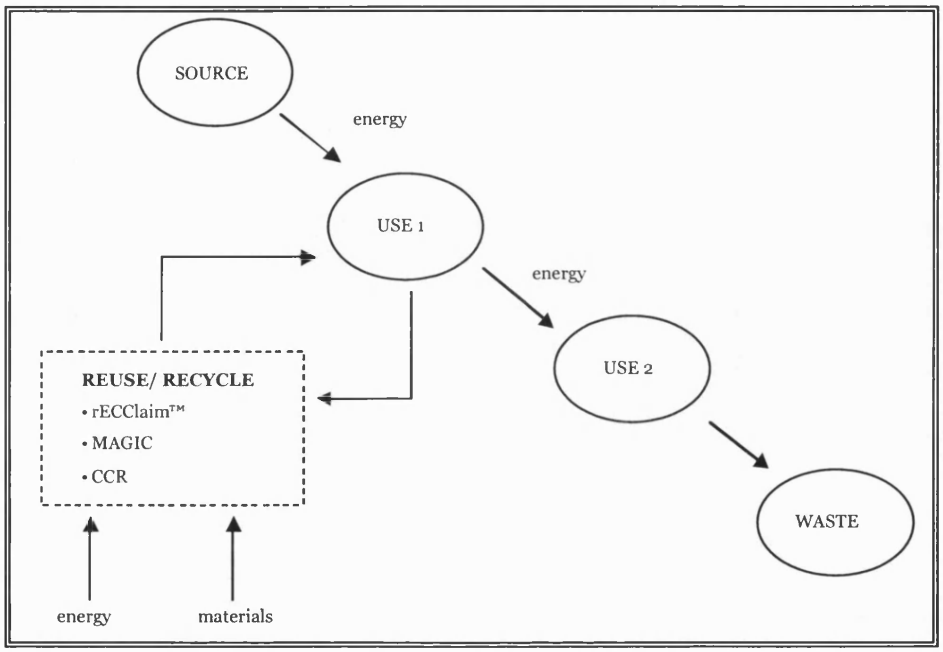

Figure 7.3: Industrial Ecology Model for Materials Use (adapted from Clift and Longley, 1996).

The rECClaim™ project, as previously described in section 7.2.2, enabled the recovery of mineral and pulp, lost as fines from the paper making process. By cleaning the effluent stream the process could substantially reduce the environmental burden of mill waste laden with organic material. Additionally the mill could over time, reduce costs through recovering valuable raw material (Transcript # 21). The MAGIC technology successfully tackled the sludge waste product of the de-inking processes which had been identified as a growing problem for the paper industry. Similarly the CCR process was

proven to both successfully recover coating mineral, leave cleaner water as a by-product (Transcript # 24) and make use of existing heat sources in the mill, reducing energy costs.

Interestingly though, while each project looked to apply these DFE concepts in the market place there was little evidence that LCA processes were used in the development of the projects themselves (Transcript # 27). This was even though one senior manager had indicated that LCA criteria could be an additional mechanism on which these processes might compete in the market place with other products with similar aims (*fn 16.4.97)*. Consequently, while these technologies succeeded technically in achieving DFE goals, this was by no mean sufficient for commercial success. Even in a potentially buoyant market for environmental technologies, each process needed to be able to demonstrate stronger economic potential in the short term.

7.4.4 Summary

Developing LCA techniques has not been considered a core task for the company. From relatively *ad hoc* beginnings the gathering of inventory stage LCI information became more systematic when a member of the research group took on the project. The inquiry has shown that, while this exercise has not been used to foster environmental improvements, it has served to highlight deficiencies in the way the company monitors some its energy and raw material usage. The most valuable results (environmentally and commercially) have been drawn primarily from the company's 'life-cycle costing' activities undertaken as part of the 'Continuous Performance Improvement' initiative.

There is little evidence to suggest that LCI work had been used to promote or contribute to DFE projects in either the production or research environment. DFE as a concept is beginning to emerge through scattered examples in the company's operations, although there does not appear to be a systematic move to include environmental criteria as part of the production design brief. The environmental research projects were implicitly developed to meet a projected growth in the use of cleaner technology in the paper industry. As such the projects conceptually embraced DFE criteria.

7.5 Partnerships and Collaboration

7.5.1 Background

I have noted previously (section 7.3.1) how over time, R&D had become physically and intellectually separated from other areas of the business. This relative independence also extended to the manner in which new projects were undertaken. A strong in-house research capability meant that traditionally the company had worked autonomously with projects being closely guarded through secrecy agreements and patent protection (*fn 16.4.97*). With a history of self-sufficient development it was perhaps not surprising to observe that the development of the environmental technologies followed similar paths. As a senior scientist reflecting on his work on the MAGIC project commented:

> "I was never in touch with other people working in similar research fields, it was really a bit of a secretive time for me ... we didn't really want the world to know that we were working on it." Transcript # 23

In essence, the development of the environmental projects appeared to track previous research trajectories utilised for the company's pigment products as described by Nelson and Winter (1982). Typically this involved creating a technically proven, complete 'product' before approaching customers. However, as the analysis presented above has suggested, the environmental research projects amounted to a significant departure from previous research efforts.

None of the three projects lent themselves to being neatly packaged, rather they could all be seen to have different requirements in terms of capital equipment and plant investment costs. Each project necessitated ECC to obtain detailed proprietary information from the mills regarding the composition of their waste streams and the costs of waste disposal. The projects also all required the installation of equipment that would have to run in tandem with the mills' existing processes. These criteria suggested the need for a close working relationship with the mills in order to secure interest and confidence in the projects. Crucially then this access depended on how the customer perceived the relative benefits and costs of adopting one of the environmental projects.

7.5.2 Customer Perceptions

Interviews with the managers and scientists who had worked on the environmental projects provided an opportunity for them to reflect on their experiences. During these

sessions several interviewees indicated how their experience of the paper industry had shown that most mills were not unused or adverse to capital outlay, as by its nature the industry is largely capital intensive (Transcript # 26). However, in the context of the environmental work, it had become clear over time that an air of conservatism existed surrounding the adoption of new technology. As a scientist working on the MAGIC project observed:

> "Mills are adverse to capital expenditure on unproven, new things; mills hate being the first at anything." Transcript # 23

This point was reiterated by a senior manager who had been working with a number of mills in an attempt to commercialise the rECClaim™ project. This manager also drew attention to the very real concerns of mills about allowing a supplier to become involved with some of the more intricate workings of their operations.

> "These mills are so hidebound, they are terrified of new technology. Because, if it totally screws them up, they can lose a fortune ... A plant itself [for rECClaim™] would cost a few million pounds and so new technology and a few million pounds, if it all goes wrong it is just a total disaster and they [the mills] don't want to do it." Transcript # 22

These factors enhanced what researchers had observed to be a general industry trait - unless under severe regulatory pressure, mills were disinclined to be first movers (*fn 14.6.99*). This was frustrating for several managers who had delivered what they considered to be successful mill trials that had technically proven the process. As one reflected:

> "A constant theme all the way [through the attempts to commercialise rECClaim™] was, we think it is a good project and we can see the benefits, but we don't want to be first." Transcript # 21

Without long-term data on the impacts of the environmental processes on mill production, managers could however understand the cautious nature of the customers they were working with. As one explained:

> "The issues which have stopped us selling it [rECClaim™] are one, it is totally new and nobody is running it... and because we've got no reference [an existing full size operational plant] we've got no data on what happens after six months ... to the machine, on how it affects production and paper quality and so on ..." Transcript # 26

More specifically though, customers (rightly) perceived that in order to determine the possible benefit of installing a rECClaim™ plant in particular, they would have to conduct a significant amount of exploratory and investigative work themselves for which there would be no short term pay back. Furthermore, once in place the new systems would require additional monitoring. As a scientist and a manager who had both worked on the rECClaim™ project in the US explained respectively:

> "In order to determine the economic benefits that they are going to pick up from this [rECClaim™] project they [the mills] need to look at a six to nine month audit of all their inputs, throughputs and outputs. It is a mass balance that they first have to identify in order to see whether it is worth adopting the technology. Mills are really not interested in putting in a six to nine month effort of doing their own analysis." Transcript # 34

> "In so far as you are basically impacting the customer with rECClaim™, you are taking the waste stream and bringing it back. It's got the potential to really mess him [the paper customer] up, so he's got to pay much more attention. He doesn't just buy the product and slap it in, it does take a lot more co-operation." Transcript # 33

Importantly therefore the analysis suggests, that work on the environmental projects had failed to assess how customers' perceptions of these new 'products' would influence the company's ability to commercialise them. Although the environmental projects differed significantly from ECC's stock of products, it had largely been assumed that existing relationships with the mills would secure access for trials and lead to successful commercialisation. Customer reservations surrounding the projects however, continued to militate against commercial success.

7.5.3 Experience with Partnering

Partnering in business and research has become more popular as companies forsake traditional go-it-alone strategies (Trott, 1998). The opportunities to share risks and resources form part of the rationale that drives companies towards more co-operative working strategies (as discussed in chapter three, section 3.4.2). It is interesting to observe in this analysis how it was only once trialling of the rECClaim™ project was underway, that the potential value of a more co-operative approach emerged. This realisation derived in part from the escalating resource costs (both human and capital) of reaching trial stage. As a senior manager pointed out:

> "To get the paper mill to a point where they are prepared to do a trial you've got to do a lot of work... a lot of small scale trialling and all sorts of things ... it will

> probably take you three to six months to get the paper mill to even allow you to run a trial at all..." Transcript # 22

Past practice had meant that the potential for a joint approach was not considered until the difficulties of commercialisation became apparent. In particular, as interviewees reflected on difficulties of the situation with the environmental projects, it emerged that that partnerships were generally not pursued by the company and had therefore not been seriously considered in this context. Several scientists noted that their established methods of research and product development, had not required a joint approach:

> "It [partnership] is not something we are comfortable with as a company ... in previous years we would have looked at what was required, assessed what was being manufactured, understood it and then made it ourselves." Transcript # 27

> "It [partnership] is not something we have done as a rule... we haven't needed to, to be honest." Transcript # 24

Ultimately though, the reasons for not placing the environmental projects on a more dynamic footing from the outset, appeared to stem from the organisation's lack of experience with building partnerships. Additionally by avoiding the need to collaborate, the company had historically always been able to maintain control of any new developments. These points are illustrated through the three comments below:

> "The problem is that our company has as a whole, a poor record with actually trying to set up JVs [joint ventures]... it just so happens that the company doesn't have a core competence at doing that, whatever that means..." Transcript # 22

> "If you can get inside a mill you have a much better chance of expanding that business for the future along more co-operative lines ... but the management just didn't know how to do that sort of thing." Transcript # 26

> "I think we like to have ownership of everything ... thinking about it, the ideal JV [joint venture] is with somebody who is in your business but not directly competing. If what you are doing is something completely new then that is when it might work." Transcript # 32

It is suggested therefore, that past practices and the organisational preference to control in-house the development of research projects, prevented the team from seeing the opportunities of a joint approach at an earlier stage. This lack of experience, it is argued, may have acted as a deterrent to exploring new avenues for commercialisation.

7.5.4 Building on Opportunity

In spite of the historical impediments to partnerships, towards the end of the study period there was growing evidence that the company was beginning to utilise the potential of closer working relationships to commercialise the environmental projects. This was particularly the case in the US where changing circumstances had come to favour the opportunities inherent in a more collaborative approach.

The initiation of the CheMin strategy (described in section 7.3.4) meant that the company could 'piggyback' chemical and mineral products in order to provide an integrated solution. In practice this involved using the established connections with mills from the chemical side of the business, in order to launch the company's mineral products. As a scientist noted, these relationships provided entry points for new business:

> "It's being a presence in the mill, it means you get to understand their processes and the way they work better. This is something that in the chemical business we've been working up with Calgon." Transcript # 24

By becoming more closely involved with the mills the US-based staff were afforded greater opportunity to engage customers and familiarise them with the new projects being developed at ECC. A manager working on building closer long term relationships with mills put it like this:

> "It is by knowing their [paper] company and their business well enough that you get them talking, and it is amazing, if you are talking you can suggest things. And then you can get them to help you conceptualise how you connect stuff together, and then they try and buy in and become part of the solution." Transcript # 32

Several scientists also commented on the benefits that this closer working relationship brought:

> "Because we have spent so much time in some these mills now [doing trials for the environmental projects] we have learned what kind of problems they have and how they think. So you get through the trialling process to form a close relationship. Some of the mill were very secretive and guarded developmentally, so we have now been able to work into that area." Transcript # 33

> "With one customer in particular we are now working on something, and it was the period of trialling the environmental technology that brought the opportunity." Transcript # 30

A second advantage afforded to the US side of the business with regard to commercialising the environmental projects, was realised by attaching the rECClaim™ project to existing precipitated calcium carbonate (PCC) pigment plants. Although PCC technologies could be considered part of the UK's technology portfolio, the company had in reality done little with its PCC technologies for some time (Transcript # 22). The realisation that rECClaim™ would be more likely to be commercially successful if attached to an existing PCC plant, was tempered by the fact that on the European side of the business, the company's access to existing PCC facilities was limited.

In the US however, the business unit leaders identified that a key competitor had over 50 PCC plants to which ECC could effectively license its technology. At the time of the study this licensing deal had yet to be confirmed, but managers were predicting that the value of the agreement would easily equal the profit forecasts had ECC gone on to commercialise the technology themselves.

The evidence presented suggests that the opportunities for collaborative or more creative relationships with customers and competitors, were being more readily realised in the US at this time. This was being facilitated by a more innovative, combined marketing approach and the steady growth in the PCC market reported in chapter five (section 5.5.2).

7.5.5 Summary

This section has considered the themes expressed in the data that relate to the company's ability to collaborate and work in partnership. I have argued that by developing the projects in isolation, the company neglected to consider the impact of customer perceptions when faced with an entirely novel process. The difficulties inherent in marketing a new project were not helped by the company's limited track record with partnering. This lack of strategic aspiration and practical 'know-how' in partnering may have militated against the early conception of a joint approach for environmental projects.

It was nevertheless observed that the company were retrospectively engaging in a more collaborative approach in order to commercialise the environmental projects. To date these tactics have been most successful on the US side of the company.

7.6 Chapter Summary

This chapter has explored the second set of propositions developed and presented in chapter three. In order to do this I empirically investigated a selected set of 'resource characteristics' that have been conceptualised as underlying a clean technology capability. The data provided in relation to each characteristic was supported by an analytical presentation of additional contextual material. Resource characteristics were analysed according to themes as they emerged from the data.

The ability of the company to work across functions was identified as being hampered by divisions between the R&D and marketing functions. These divisions related to both structural and cultural differences with three key themes emerging during the study. This lack of interdisciplinary working hindered the successful commercialisation of the environmental projects and left knowledge 'gaps' in the project life-cycle. The introduction of more progressive management approaches, including technical road mapping, looked set to improve the company's approach to innovation. However this new work was ostensibly too late for the environmental projects, as enthusiasm and support for the projects had been noticeably tarnished by experiences to date.

Evidence relating to the development of LCA work suggested that at the time of the study, the information obtained had not passed the report stage. Although the company was clearly involved in increasingly detailed data gathering and information provision for customers, there had yet to be any attempt to apply this knowledge in a practical sense in either the production or research environment. Improvements in environmental performance had largely been achieved through the company's more broad-based, 'Continuous Performance Improvement' initiative that drew on 'life-cycle costing' techniques. Examples of the application of DFE principles existed in 'pockets' in the production environment brought, it is argued, by a growing awareness of environmental issues and improvement drives more generally in the company. The environmental projects embodied the concept of DFE as applied in the company's main market. Surprisingly though, the development of the technologies themselves did not appear to embrace DFE principles.

With no history of partnerships or contemporary aspirations to engage in collaborative working, the company experienced difficulties during the commercialisation phase of

the environmental projects. These problems were particularly apparent during the trialling phase of the rECClaim™ project, where it was identified that the organisation needed to be more knowledgeable about the specific issues in mills. A more progressive management approach at the company was beginning to recognise the value of co-operative working, particularly in the US based business units.

These findings have implications for the relative strengths and weaknesses of these resources characteristics as applied to this case. Considered cumulatively, the evidence provides insights into the capacity of the case company to develop an environmentally (and possibly competitively) valuable capability in clean technology. These key issues are considered in more detail in chapter nine, where I draw together the evidence presented in the three analysis chapters and make an assessment of the case findings from a pragmatic and a theoretical perspective.

Chapter Eight: Moderating Environmental Capability: The Role of Firm Specific Factors and the Development of Environmental Institutional Capital

8.1 Introduction

This chapter explores the final two sets of propositions developed in chapter three. The first three propositions address the potential of selected factors internal to the firm to moderate the relationship between identified resource characteristics and capability development. The final two propositions explore how two identified areas of organisational context may contribute to the development of environmental institutional capital. The five propositions are shown in Figure 8.1.

Moderating Factors and Selected Elements of Environmental Institutional Capital
3a. The development of pollution prevention and clean technology capabilities will be moderated by non-environmental organisational strategies.
3b. The development of a pollution prevention capability will be moderated by a firm's track record on environmental issues.
3c. The development of a clean technology capability will be moderated by a firm's experience with innovation.
4a. A firm is more likely to develop the capacity associated with environmental institutional capital when it can demonstrate a proactive relationship between its operational activities and the natural environment.
4b. A firm is more likely to develop the capacity associated with environmental institutional capital when it can demonstrate a proactive relationship with its stakeholders.

Figure 8.1: Research Propositions: Moderating Factors and Selected Elements of Environmental Institutional Capital

The analysis presented in the following sections derives substantially from the qualitative, interview element of the study. Significantly, however, the issues raised in this chapter also owe much to the periods spent in the field both on site at operations, and in the office environs of the company, where supporting data was collected through notes and observations.

In this chapter it is important to observe that the analysis is framed more broadly by the internal moderators and elements of institutional capital that were introduced through the proposition development in chapter three. As such, the discussion may span themes that are relevant to the pollution prevention and clean technology capabilities respectively, in the same section. To maintain clarity and flow, I therefore present framing background material at the start of each section, rather than in a first 'overarching' introductory section as in previous chapters.

The chapter breaks down into five main sections. In each section, I first provide the introductory materials that supplement the analysis, before addressing the research propositions drawing, in turn, on issues and themes as they arose in the data relating to both capabilities. In several instances, key events act as exemplars of the analysis themes. The chapter concludes by summarising the main findings and points to those issues which will be discussed further in chapter nine

8.2 Non- Environmental Strategies

8.2.1 Background

In chapter three (section 3.5.1) I introduced and made the case for identified factors internal to the firm to act as moderators in the development of environmental capability. In particular, I noted that in any organisation, strategic initiatives will be competing for human resources, capital and political support. This situation can be significantly influenced by periods of organisational turbulence and uncertainty. At ECC, the study period had been preceded by a prolonged period of substantial organisational change (see chapter five, section 5.3.1). While the pace of change had slowed towards the end of the 1990s, there continued to be ongoing drives in a number of key strategic areas. These initiatives included:

- an IT strategy targeted at taking the company through the year 2000 and beyond using new integrated software for the purchasing and product controls (ECC, 1998);

- a 'Kaolin Battle Plan' aimed at finding new ways to generate cash from the company's core business in order to meet the challenges from the emerging Brazilian market (ECC, 1998);
- a communications drive, using management teams and focus groups.

At the heart of these projects was a strategic and fundamental change to the way the company did business that stemmed from a performance-driven management system, the Continuous Performance Improvement (CPI) initiative (introduced in chapter seven, section 7.4.2; ECC, 1999). CPI focused on a range of company activities from production processes to procurement and represented a new and very different way of working for this organisation. Introduced in 1996, CPI sought to deliver significant cost reductions for the company in the region of £30M over two years. The initiative used a team approach and worked in 12-week cycles. Teams were led by a senior member of staff and drew their members from across the functions. With a focus on cost reduction, the teams sought to 'weed out' redundant practices and inefficiencies in the system that may have accumulated over time. As noted previously, this work included reviewing areas such as water and energy use where environmental improvements were also achieved, although arguably as a by-product rather than an objective, of the cost reduction exercise.

The remit of the environmental initiative launched in 1997 (chapter six, section 6.2.2) was to address environmental improvements more directly and explicitly. Conceptually, the environmental initiative shared the 'performance improvement' ethos introduced by CPI as reflected in the more challenging targets adopted by the company (see Figure 6.2). However, discussions with the interviewees suggested that the environmental initiative was generally considered to be of lesser importance when compared with other CPI processes. In particular, there was a pervading sense of priority towards initiatives that were specifically contributing towards the short-term commercial viability and financial stability of the company at that time. Environmental work with its inherently longer-term goals was (it is suggested) considered less strategically important for the company. As a result, environmental work both in the operational and research environment could be seen to be losing some of the internal battles for staff time and resources. These issues are reflected through the discussion in the following sections.

8.2.1 Strategic Priorities

During the study, there appeared to be an emerging understanding from respondents (particularly those who had become involved in environmental activity for the first time) of the potential business benefits of engaging more proactively in environmental work. With this new understanding in place, some of the staff I spoke to were becoming concerned that environmental work was being neglected in the face of more 'high profile' work. Comments from a member of the environmental team and an operations manager reflect this analysis.

> "There is not a recognition with all the other [ongoing] initiatives that the environment is a fundamental part of the way business has to do business ... it is still lacking here and I really can't see it changing in the foreseeable future." Transcript # 7

> "I think the environment has been given secondary importance ... I think certain people obviously see it as a necessary evil, rather than a key area of company activity." Transcript # 10

The ongoing drive for cost reduction also meant that projects requiring an 'up-front' injection of funds were viewed less favourably at a strategic level. Driving forward environmental work was therefore fundamentally more challenging as one manger explained.

> " ISO 14001 is viewed as an improvement initiative, but it is one of many, and I suspect is slightly less important than CPI ... I think the perception of ISO 14001 or an environmental management system is that the long-term benefits are there of course, but there are potentially short-term costs as well. So that may be a thought that influences [senior] people to give other initiatives higher priority." Transcript # 18

Several managers suggested that this prioritisation was in part responsible for the difficulties they were experiencing in terms of finding adequate resources to carry out the environmental work. They recognised that environmental work required dedicated staff and consistency but the mounting pressures made this task problematic. Their comments pointed starkly to the impacts of the recent organisational changes on the progression of environmental objectives.

> "CPI has been around for nearly three years now, but with the general trend towards de-manning it makes this [environmental] work increasingly difficult to actually do." Transcript # 6

> "There are an awful lot of things happening at the moment and obviously, the difficulty of getting environmental work done, it is a people resource, you just can't be in two places at the same time." Transcript # 9

These points were confirmed by a manager more closely linked to the management of environmental work who stated that:

> " I think where it [work on the environmental management system] has not been pushed along enough is totally through resource ... there are just not enough people available to brainstorm and do this sort of work in the company." Transcript # 18

These comments illustrate clearly the complexities inherent in pushing forward an initiative that is not necessarily viewed as contributing core value to the business. These problems may have been compounded by an awareness of the need for up-front investment of financial and human resources, in an uncertain organisational climate. In this case it is argued that competition with other organisational projects compounded the difficulties faced by the environmental work and acted to hinder progress.

8.2.2 Worker Morale

The ongoing impacts of organisational restructuring and de-manning had resulted in an increasingly challenging task environment. In chapter six (section 6.5.1) I pointed to signs of worker discontent and reduced morale as a result of organisational changes. In particular, I highlighted a growing distance between senior staff and operational level workers. The cumulative impacts of an additional initiative with high labour requirements, such as the environmental project, could be seen to fall primarily on operational staff. For some middle managers there were clear signs that this combination of factors could be contributing to the air of discontentment amongst workers.

> " The company has had lots of new management, lots of restructuring, lots of new ways of doing things, which now include the environmental work. The production people are the biggest group all told, about 2,600 and they are the ones who lose most every time. And they see themselves being pared down and people in senior positions being recruited. We are busy recruiting market strategists and market analysists ... you know what I mean ... and the lads out there, they are struggling." Transcript # 1

This perspective was confirmed by the comments of an operational manger who expressed the personal difficulties he was encountering while trying to juggle the demands of the various company initiatives.

> " I find it [CPI] extremely difficult to manage when you have the new environmental work and you have to keep everything else going as well and your day job has to go on ... you get forced to a point where you have to do evenings and weekends just to keep up." Transcript # 11

This air of de-motivation brought in part by the pressures of competing initiatives, pervaded throughout the study, with many staff expressing their opinion that the workforce had been trimmed too thinly (*fn 23.4.97*). A respondent to the project questionnaire took the opportunity to express the following comment:

> " 1. ECC has downsized its labour force too much. People do not have the time to do their job properly or to think;
> 2. Many core and basic tasks are missed and this can only lead to long term problems;
> 3. The company depends on the goodwill of their staff, but the rewards are not fairly distributed." *Qn 365* (Senior Buyer)

It is interesting to observe, that while interest in and enthusiasm for environmental work was generally high (as indicated in chapter six) it was difficult for staff to separate the demands associated with environmental work from the other organisational initiatives. This meant that the pressures of environmental work could be framed in similar and potentially negative ways. As a result environmental management, when considered in the context of other organisational initiatives, appeared to be contributing to lowered worker morale. This was even though evidence from other elements of the study pointed to an enthusiasm for the environmental management programme (chapter six, section 6.5.3).

8.2.3 Loss of Personnel and Creative Space

In chapter seven, I drew attention to some of the difficulties faced by the environmental projects on the road to commercialisation. In particular I highlighted how the projects were vulnerable to changes in the makeup of the development team (chapter seven, section 7.3.3). The loss of key individuals was retrospectively recognised to have fundamentally slowed progress. These changes were brought primarily by the strategic initiative that created the business units. The formation of the business units witnessed

the redistribution and secondment of personnel away from existing, non-priority projects, which at this time, included environmental work. It also severed some of the established connections that staff had made in the market place.

> "In Europe they have gone through a lot of changes organisationally and I know that all the European [paper] companies that I have visited in the last couple of years say that, 'you have lost the continuity', they see a new face coming and it is all change." Transcript # 32

As this senior manager went on to point out, although the reorganisations had brought positive changes, these initiatives had also resulted in a loss of continuity necessary for environmental work.

> "With new people in the management ranks it take a longer time to understand the products, the customers and how you actually make money [in this organisation]. You've got to protect embedded knowledge and you need a core of people [for environmental work] that form your expertise. It is good to have some sort of turnover, but you also need to have some continuity, some basic understanding." Transcript # 32

This point was reiterated by a scientist who was working on developing new technology for the MAGIC project:

> "When I was first brought in, there was a team of about 4-5 of us on it [MAGIC] at the time. Then we went through another rationalisation and the formation of the business units and it was just [another named scientist] and me. So I was left pretty much to my own devices." Transcript # 27

Interestingly therefore, even though the environmental projects as research 'entities' survived the improvement and rationalisation initiatives, they experienced negative knock-on effects brought by these organisational changes.

For the scientists involved, these impacts extended beyond the loss of key staff to more fundamental issues about the way they conducted research itself. In chapter seven (section 7.2.1), I described how the more innovative environmental research stemmed from a 'corporate research group' that was given the remit to investigate new R&D opportunities for the company. Changing strategic directions disbanded this research group, but crucially for the scientists involved in the new environmental projects, it also removed the creative space that acted as a breeding ground for new ideas. As a senior scientist and a senior managers respectively expressed in interviews:

> " The business unit approach means that we can no longer do the interesting projects that we considered before." Transcript # 24
>
> " The negative side of the reorganisation initiative is that there is no imagination in it [research] at all now, and I don't just mean imagination from an R&D point of view... I mean imagination anyway. I find it hard to believe at the minute that our business units would think about something like [rECClaim™] supplying a totally new type of product to a customer. They are only short-term focused." Transcript # 22

These opinions were confirmed by a number of scientists during the course of the study. Most understood and accepted the business rationale for the commercial priorities reflected in the new links to the business units, but expressed dissatisfaction that some of ECC's inherent creative talent was being suppressed by the new market-focused approach to research.

8.2.5 Summary

The themes emerging from interviews and fieldwork at the company suggested that other competing, non-environmental initiatives had had a largely negative impact on the development of the environmental management programme and the environmental research projects. The environmental management work, in particular, was identified as being a labour intensive initiative with a strong reliance on operational staff. Therefore where other initiatives were afforded priority, particularly in terms of human resources, the environmental management programme struggled to progress. With worker morale already dampened by the rolling effects of organisational changes, environmental work was in danger of being perceived as an additional burden for an already stretched workforce. This finding ran counter to the experiences of workers when asked to consider environmental work in isolation.

For the environmental projects, competition with other organisational initiatives resulted in a loss of personnel that damaged both the integrity of the research teams, and also the continuity that characterised strong customer relationships. Additionally it is suggested that the creative aspirations of the research group were curtailed.

8.3 Track Record on Environmental Issues

8.3.1 Background

In chapter five (section 5.6.2) I outlined and discussed in some detail, the key environmental issues associated with the winning and working of clay minerals at the company's Cornish based production units. In particular, I drew attention to the issues of air quality, water quality, waste, habitat and ecosystem change, noise and vibration in the operating environment (see Table 5.3 for a summary). The discussion pointed to the difficulties of managing this range of issues in a small geographical area, where residential and other commercial concerns exist in close proximity to mine workings. I also described a range of management practices and mitigation measures adopted by the company to address some of these concerns. These activities, it was argued, reflected changes in the social and policy context of the operations. With a growing public awareness of the environment it was suggested that environmental issues have transcended their marginal status and become more closely associated with 'quality of life' concerns. More specifically it was recognised that the demographics of the china clay area have changed progressively over the last 20 years with proportionately less of the population who live in the area being employed by the company. Additionally, the regulatory environment has matured, with the creation of the Environmental Agency in 1995 signalling a more integrated approach to environmental legislation and management. While focusing on contemporary activity, the analysis in chapter five implied that practices have evolved gradually over time as these attitudes towards the impacts of mining and regulatory requirements have changed. Important though, is the recognition that the most significant changes have largely taken place over the last 30 years.

Historically the company had limited measures to control or mitigate the environmental impacts of mining, a position explained by a number of factors. Several hundred years of mining activity had created an increasingly intractable legacy of mine tipping and workings. Continued growth throughout the twentieth century, and the need to avoid sterilising the clay resource had militated against an integrated solution to manage the backlog of waste generated by mining. The economic importance of the company both locally, in terms of employment, and more broadly as an economic driver in the region, created a population that was largely supportive of mining activity and tolerant of its

impacts. As a significant landowner in the area, the company was able to shield itself from external influences, a situation enhanced by the limited and largely inadequate nature of planning regulations at this time (*fn28.2.97*). This combination of influences, meant that the company was used to working relatively autonomously, in a decision-making framework that favoured economic factors.

As a result, the company's experiences of environmental management and change reflect a relatively recent period in the organisation's history and are built on a much longer and more substantial pre-environmental management model of thinking. An examination of employees' perceptions and reflections of change, showed two clear themes emerging. These themes are expanded in turn below.

8.3.2 'Getting away with it'

I have identified in previous discussions (chapter six, section 6.2.1) that the company had been slow to address environmental concerns in any systematic or integrated way. As a consequence, the new strategic environmental initiative introduced in 1997 faced a substantial task in terms of developing and co-ordinating a programme capable of tackling the inefficiencies and occasionally sub-standard practices that had amassed over time. In particular, the team needed to address both the limited use of best practice techniques and significantly, the residual 'pockets' where some workers considered that environmental issues were of reduced importance in the context of the operations themselves. This lack of concern could, in some instances, be closely attributed to the mining legacies outlined above. Several interviewees reflected on how this burden had hindered work and influenced thinking.

> "Until the early 1970s not a lot of landscaping took place, and we have inherited from our forefathers an awful lot to catch up on." Transcript # 9

> " Thirty years ago there were no restrictions at all, you just tipped and that was it." Transcript # 14

> "It has always been fairly easy in the past. OK, the odd bit of leakage here and there and it hasn't really caused any problems. In the country no one really bothers that much." Transcript # 14

The evidence suggested that this situation was often compounded by the autonomy and relative freedom granted to managers who were responsible for expansive sites. As both a senior manager and an operations manager explained;

> "A manager's patch is very much a manager's patch, and there have been things going on out there [with respect to the environment] over the years that have simply not been questioned by anyone. This is largely because a site manager carries such a responsibility legally ..." Transcript # 12

> "If you go back a number of years we [ECC] used to own all the houses around the works. The manager then, he was law in all areas, I mean he decided who had a house and who didn't." Transcript # 9

This autonomy meant that historically, the different production sites adopted their own practices. With limited interaction between sites and no central reference point for environmental management, workers could become fixed in their methods and reluctant to discuss problems when they occurred. As a member of the EMS team reflected:

> "The organisation has been fairly static out in its production environment in that, 'that's the way we do business boys'... it is realising what the effects of poor environmental practice are on site. Before it was very much all dealt with in a 'hush hush' manner and kept 'under the covers'." Transcript # 7

These comments were drawn from employees with first hand experience of environmental practice on site. It is therefore interesting to observe how the broader conception of environmental practice within some quarters of the company also reflected the negative elements of the company's approach to date. Importantly these respondents felt that in their experience, the company avoided engaging proactively with environmental management.

> "I feel that ECC do the bare minimum where environmental issues are concerned. If they can get away with it they will." *qn 127* (Engineer)

> "ECC tends to do these environmental things because they feel that they <u>have</u> to rather than because they necessarily <u>want</u> to." *qn 178* (Product developer, original emphasis)

The evidence presented here suggests that ECC were used to 'getting away with' particular practices and the legacy of working methods made reforming practices difficult. The relative autonomy of site managers meant the quality of environmental

work could vary and frequently the level of engagement depended entirely on the individual interests of the manager. With a relatively static work environment, it was easier for workers to continue with existing ways of working, and hide inadequacies rather than laying the groundwork for change.

8.3.3 Towards Compliance

The analysis in the previous section pointed to practices that reflected a history of self-regulation, where production requirements dominated the decision-making context. Importantly though, past practices were based largely on a knowledge and understanding of the issues at the time. As an operations manager indicated:

> "Unfortunately it [environmental damage] was something that was never thought about before in this way. It was totally acceptable to put engine oil down the drain." Transcript # 11

However, with production pressures on the environment growing, and the emergence of new regulations and guidelines for mineral working (DOE, 1991), the evidence suggests an increasing awareness of the need, in this organisation, to establish more measures to combat environmental impacts. This realisation appeared to move the company towards a more compliant position, designed to avoid regulatory penalty or conflict with other stakeholders. Reflections from three interviewees illustrate this point:

> "I think in general the track record [of the company on environmental issues] is very good. We've always been broadly compliant in terms of effluent and stack emissions. Dust has caused a little problem but that is usually due to weather conditions." Transcript # 14

> "I feel we have done things in the past that we didn't actually need to do just to be good neighbours, and you do have to judge these things by the social norms of the time." Transcript # 9

> "I think in broad terms we have become more environmentally conscious, you know we've been grassing our tips for some time now." Transcript # 6

For these managers, the progression towards a compliant position was both a satisfactory and a sufficient stance for the company to adopt. It is argued that in this case compliance was considered to be an 'end goal' rather than a minimum position that the company should aspire to. As a result there was little drive or incentive to progress beyond this level which, as discussed in chapter six (section 6.2.2) meant the company built its environmental practices on a limited framework characterised by a reactive

approach. The message emerging from past practice was one of inertia and reactivity that, in the opinion of several questionnaire respondents, had limited the opportunities available to the company in the long term.

> "At ECC we tend to respond to legislation, rather than taking the opportunity to lead the way with environmental standards." *qn 262* (Mines Manager)
>
> "In my perspective ECC has only ever been reactive developing environmental management and care. We may have missed the business benefit of being proactive and taking a lead in the industry." *qn 438* (Marketing Manager)

These comments point to a changing perspective and an accompanying recognition of the need for the company to be broadly compliant with environmental regulation. However, by implication some interviewees felt this (compliance) to be a sufficient level of engagement with environmental issues. This contrasted with the view of others who, on balance, felt that this stance had the potential to lower the horizons for environmental achievement.

8.3.4 Summary

What we see emerging from the experiences of interviewees is a way of working that arguably reflected the local power and dominance of the organisation. Typically this meant relegating the management of environmental impacts to a lower priority (with the notable exception of the highly visible tips). Interestingly, a substantial number of the operational managers interviewed during the study had long service records with the company (between 20 and 30 years) which afforded a long-range perspective of company environmental work. This enabled them to retrospectively see a two-stage track record that latterly included a progression towards more compliant behaviour, although, as noted in chapter six (section 6.2.1), this change showed little evidence of being strategically driven.

The lack of any strategic intent in past approaches to environmental issues is in part explained by the then limited understanding of how environmental impacts and damage can occur. For some staff, this had resulted in a situation where the company may have missed the opportunities inherent in a more proactive stance.

8.4 Experience with Innovation

8.4.1 Background

In chapter three (section 3.5.3) I discussed and made the case for experience with innovation to act as a moderator in the progression towards a clean technology capability. I doing so, I implicitly drew on arguments in the literature review (section 2.10.2) that stressed the importance of history and path dependency in the development of organisational capability (Nelson and Winter, 1982). For environmental innovations these elements were considered to be of particular importance because conceptually authors have suggested that, the development of 'greener' innovation activity demands new ways of thinking and working (Winn and Roome, 1993).

The contextual development in chapter five illustrated how ECC's R&D activity has spanned a range of products and markets. In this study I have chosen, for reasons discussed previously, to focus on issues and developments in the organisation that relate to the paper industry, which at the time of the study was the company's most important market.

I showed in chapter seven (section 7.2.2) that the rationale for developing the new environmental projects was one of perceived demand and potential, as reflected in existing company skills and expertise. However, the analysis also revealed that there was little attempt by the research team to assess to what extent the environmental projects would take them beyond their existing competencies, particularly with respect to the link between development and application. Of specific interest to the following analysis is the finding that the team did not conceptualise the environmental projects differently. In fact, as noted previously, this point appeared to remain unresolved during the study period.

The analysis in chapter seven pointed to difficulties with commercialisation for each of the three environmental projects considered. The exploration of the data in the following sections builds on these finding by suggesting that the company employed static working regimes for what were conceptually more dynamic and complex innovations. Problems were focused around the key areas discussed further below.

8.4.2 Dominance of Technology-Push

As the study progressed, and managers and scientists reflected on their experiences with the environmental projects, it was salient to observe that much of what the company had done in terms of research relied heavily on their technical ability to deliver. Less attention and focus was given to how market forces could influence the direction of development. While the impetus for the environmental projects had initially come from outside the organisation, the methods employed to address the problems followed past practices of in-house development. In essence the researchers worked within an existing framework that reflected what they were capable of, rather than asking the question, what does the market require? As a marketing manager working on the rECClaim™ project explained:

> "The justification [for the projects from R&D] was put forward without enough people understanding what it was going to be like in the market place... The problem with the company is that everything was fundamentally about selling clay and most of R&D ... they were doing nothing really which was going to take the company forward in terms of profit. [But] it [R&D] was doing a lot to promote itself as a world-wide acknowledged centre of excellence." Transcript # 26

When probed further on this issue, this interviewee commented that the company was very good at developing technology and this was a recognised skill, both internally and outside the organisation. However, experience at applying this new sort of technology was, at best, limited.

> "We knew everything about precipitation but not really a lot about preparing the sample apart from de-watering. Then we did studies on stickies and colloidals and we only did that work as a result of questions that were coming back from the mills about the runnability of the processes." Transcript # 26

As a senior marketing also pointed out:

> "I think it is really easy from an R&D perspective to get excited about environmentally driven projects." Transcript # 32

However, as he then went on to discuss, translating this enthusiasm into a commercially viable product, even with strong research expertise, was a far more challenging remit. This perspective was confirmed by a scientist, who reflected on his experiences of development work:

> "You can spend a very long time [working on a project] and then you go to apply the process in a mill and you find you know nothing." Transcript # 24

Interestingly though for this analysis there appeared to be, even in senior circles, little recognition that while technically proficient, current modes of working did not necessarily serve the environmental projects well.

> "When I first joined the company we had a better sense of balance somehow, in that we recognised that if you worked a bit and you'd advanced the knowledge, but not quite far enough to do what you were doing the fine, you put it back on the shelf. A few years later you'd know what to do and bring it back off." Transcript # 32

This comment illustrates the relative freedom that had characterised R&D working prior to the company reorganisations, and showed a strong reliance on a characteristically 'technology-push' model of working. In particular, this method of development depended more heavily on the opportunities afforded by a wider and unlimited creative space (which as I showed in previous analyses had diminished in the company's R&D environment).

> "It seems that a lot of things [with this environmental work] happen by luck, if you are busy enough and doing enough things, something will be lucky and pay off." Transcript # 32

In spite of this apparent reluctance to depart from established ways of working, the costs of adhering to outdated modes of working were becoming clearer, particularly in the US part of the company. Here, (arguably) improved management and use of research expertise had brought the company closer to the market. As one senior marketing manager commented, when highlighting a key failing of the rECClaim™ project:

> "Being a leader in environmental technology is a kind of risky place to be, so it is real important to do your homework up-front, especially when the development of new technology is going to require a lot of investment.
>
> Although we have developed some great technology and customers appreciated the fact that we were doing the work, I think in every case it wound up not achieving much of its potential because in the end it cost the customer money to change his process." Transcript # 31

A cumulative analysis of these comments points to a company attempting to develop a new 'breed' of project without first considering the need to adapt existing models of

working. Experiences to date had favoured the technology-push trajectory facilitated by a strong research base and as a result researchers had been led to apply existing regimes to the environmental projects. This may have been a contributory factor that hindered progress, particularly in the application phase of the work.

8.4.3 Product Focus

With the dominance of technology-push came a rather restricted 'product focus' that derived from the company's development experiences to date. Conversations with a range of managers and scientists revealed that 'conceptualising' the environmental projects in a way that people from across the functions could understand was a major challenge and that ultimately it was something that had continued to allude them. This confusion was evident from the spread of comments on this issue. When considering the changes necessary for ECC a senior marketing manager stated that:

> "The minerals business tends to be more asset driven. Therefore, thinking about it some of these environmental technologies were kind of a departure from the mainstream for ECC." Transcript #30

More specifically, a second respondent involved in marketing the environmental projects noted that:

> "When you start talking about chemical plants, which is really what rECClaim™ was, then it is not necessarily out of our depth, but it really is not your comfortable area." Transcript # 25

In departing from the product-focused 'comfort zone' the environmental projects took scientists and marketing staff into an area where they were less experienced and this situation brought with it more potential for disagreement between the functions.

> "At the end of the day, although we've got a very, very competent engineering department, we are not in the business of selling engineering units [as would be required by rECClaim™]. That's not our concern and there was a conflict that didn't quite fit in." Transcript # 25

It was interesting to observe through the analysis of this situation that there appeared to be an unwritten agreement about where the company did and didn't go in terms of project development. This situation created difficulty for one marketing manager in his attempts to commercialise the projects.

> "I've always argued that what we are selling [with rECClaim™ in particular] is capital equipment and not a material product." Transcript # 26

Conversations with some of the senior managers who had been involved at this time suggested that some of these potential faults in the development process had now been recognised.

> "I think we have learnt the lesson that a good idea and one which you can make work technically ... that the translation into commercialisation and actually selling it is a very big transitional step. How are we going to sell it? What are we going to do to sell it? ... that would be the 'take-away' from rECClaim™." Transcript # 21

> " They [the environmental technologies] have been harder to commercialise than we anticipated at the time and you could perhaps argue that we weren't focused enough on the market and were just dreaming things up." Transcript # 23

The evidence presented by both scientists and managers in this section hinted at difficulties that derived from the conceptually different nature of the environmental projects from previous R&D work. Although the company had extensive experience in developing new technology, most commercial experience related to clay products and could not be easily applied to the environmental technologies.

8.4.4 Negative Impacts of Environmental Work

In chapter seven (section 7.2.1) I indicated that during the study period, each environmental project was at a different stage of development. This, I suggested, provided an opportunity for a more reflective analysis of the firm's work on environmental innovation. To this end, interviewees were invited, where appropriate, to consider how their experiences of environmental project work to date might influence future company developments in this area. The emergent theme from both managers and scientists was strikingly negative. It showed how early difficulties with rECClaim™ had created a knock-on effect for the other projects that followed.

> "I think the fact that they [the environmental projects] have not made money has had a very negative effect. We're back I guess, to where we were seven or eight years ago when it would be really severe pressure from our customers that would be needed to make us do this sort of thing again." Transcript # 20

> "We are certainly not looking to produce new environmental projects. The result of all this has been so negative that I can't imagine us going any higher."

> "The bit that was worse about it [MAGIC] was that it did have the stigma of rECClaim™ and the capital requirements were even higher and even worse than that... The product itself [MAGIC] was potentially a replacement for one of our own existing products." Transcript # 22

On reflection one senior manager concluded that, though negative, the company had in his view learned from these experiences.

> "The sort of marketing of products and analysis of industry in general has improved somewhat and in terms of R&D organisation we are now in third generation, which just doesn't do these sort of things [environmental projects] anymore." Transcript # 20

It is important to observe that, in this analysis the articulation of this view was limited to a number of more senior managers, whose position afforded them overview of proceedings to date. The opinion that the commercial failure of the environmental projects had created a stigma around environmental research work in general, was nevertheless shared informally by a number of scientists I spoke to during the course of the study.

8.4.5 Summary

The data presented in this section revealed that the innovatory environment at ECC was characterised by a static regime. The existing expertise of the company strongly favoured a 'technology-push' approach to innovation management that did not necessarily address the challenges embraced by each environmental project. With research and commercial activity typically focused around products the more dynamic and less easily framed environmental technologies created a conundrum for the company, particularly when the project reached the commercialisation phase. This difficulty with commercialisation tarnished the internal popularity of environmental work and created a context unlikely to support future development in this area.

8.5 Relationship between Operational Activities and the Natural Environment

8.5.1 Background

The development of the case in chapter five and the subsequent analyses have emphasised ECC's long and rich history in Cornwall. These discussions have also served to highlight the importance of organisational context in developing an appreciation and understanding of this case. A key facet of this context relates to the company's relationship with the physical environment in which mining takes place. The discussion so far has suggested that the company has drawn both economic and cultural wealth from the mineral referred to locally as 'white gold' (see chapter five, section 5.4). However, historically less attention has been given to the non-clay bearing land and surrounding areas, which, in a mining context, are considered to be of intrinsically reduced worth. The consistently strong economic value of the clay mineral has meant that for most of the company's operational history, mining has been the most important land use in the area.

Yet while the economic value of the clay mineral has largely been sustained, the physical, social and policy context of mining in this area has changed. The availability of tipping space for mineral waste has reduced over time with existing infrastructure and networks creating constraints. Additionally, communities have become more interested in retaining and conserving those areas and spaces that have, to date, remained untouched by mining activity or that have acquired heritage value. These changing societal requirements have, in recent years, been reflected in the policy documents that influence the spread of mining activity in the area (CCC, 1996). These observations point to a new climate in which the company has been required to consider a number of competing demands for long-term land use.

Against this backdrop of change, analysis of the company's contemporary activities suggested that moves were being made to redefine the relationship with the natural environment. In particular, the 1997 strategic (level) decision to address the organisation's impact on the environment through revised policies and practices (discussed in chapter six, section 6.2.2), signalled a more integrated and holistic approach to managing the operations/ environment interface. Evidence gathered

during the study suggested that this new strategic intent was beginning to manifest itself in the way that interviewees framed the company's relationship with the environment. The discussion in chapter six pointed to a range of trigger factors for this new approach that included signals from the market place. In the next section I suggest that this changing relationship was also driven by company experiences closer to home and, in particular, was exemplified by the revision of a planning permission for an extended tip at the Wheal Remfry china clay works. Importantly though, the data also pointed to these changes being tempered by the practical realities of managing operational failures such as pipeline breakages.

The emergence of this new perspective and the difficulties involved in pursuing a positive relationship with the natural environment are explored in more detail in the sections below, which draw on two illustrative examples.

8.5.2 Strategic Intent

The decision to implement a company-wide environmental management programme through the ESH initiative marked a significant change in the way the company 'officially' viewed its relationship with the natural environment. During the study period this formal commitment to change was developed further through a new environmental policy for the operations in Cornwall and Devon. The policy stressed the importance of 'dialogue with environmental stakeholders' as well as 'continual improvement' in environmental performance (ECC, 1999). However, it is suggested, as some authors have also argued, that policy changes at a strategic level do not necessarily ensure actual change and implementation at operational sites (Bowen, 2000b). Important therefore, was the evidence gathered through interview and fieldwork, that also pointed to a new awareness of environmental responsibility and a re-framing of the company's activities in an operational context. As several managers from across the operations commented:

> "We have a policy now of not just being compliant but being well ahead... there is a natural responsibility of operating in today's environment. I think there is a recognition now that you can't destroy the countryside for future generations." Transcript # 14

> "I think you can't just turn a blind eye to environmental issues anymore, that would just show out and out arrogance. We want a nice place to live but we also accept that we have to have industry alongside. I noticed that as soon as we tidied up our

> entrance, changed this tip and put some trees on it, people started to walk past with their dogs." Transcript # 11
>
> "I think we all, everybody, sees the need to improve and be aware that the environment is finding it more and more difficult to bounce back when we hit it with something and I think it is a question of personal responsibility to go ahead and do what we can." Transcript # 15

More significantly some interviewees had begun to appreciate the close nature of the operations/ environment relationship and in doing so were beginning to consider new avenues for the company to pursue.

> "We are as environmentally linked as farmers are, as we are actually dealing directly with the environment in a way that few other business do ... there is a development opportunity in getting more fundamentally involved with some of the aspects like landscape definition and cultural heritage." Transcript # 7

The data suggested that these changing attitudes had been influenced by the company's recent experiences of pursuing planning permission for new tipping space at the Gaverigan. These experiences are explored in Box 8.1 below.

The Gaverigan Tip

Background

The discussion in chapter five (section 5.6.2) described the large waste to product ratio (9:1) that exists in the clay mining process and discussed some of the key problems relating to waste disposal. At ECC, the limited tipping space was becoming an increasing problem in the mid 1990s and this was particularly the case in the Fal district (situated in the North West corner of the clay production area). Here, the ceramic clay pits were faced with a situation where twenty years reserves were set against only two years of available tipping space. In view of this position, ECC submitted a planning application to dispose of clay waste on company owned land at Gaverigan, adjacent to the Wheal Remfry Clay works.

In 1996 following a public inquiry, the Mineral Planning Authority (MPA) rejected the company's application on the grounds that it had failed to satisfy 'strategic, environmental and landform considerations' in the area (ECC, 1997).

Reflections

Discussions with staff during the study period implied that the company had been shocked at the rejection of the planning application. There appeared to have been an assumption amongst a number of staff that, because there was an accepted case (within the existing planning

framework) for extended tipping capacity, the company would not have any problems obtaining permission. Additionally it had always been 'understood' that the company had a close working relationship with the MPA.

On reflection however, some of the people I spoke to commented that the rejection had been an important awakening for the company. It was suggested that the economic dominance of the company frequently resulted in a 'we know best' mentality that, in this instance, had not been accepted by the planners. This misplaced self-belief had led the company to perhaps take less account of the strength of local opposition to the scheme, and the full detail of potential environmental impacts. Further, it was noted that the recommended criteria from the Wardell Armstrong report (for the landscaping and revegetating of china clay wastes) had not been closely adhered to.

Learning

In resubmitting the application the company made some important steps forward to address the concerns by the planners. This meant adopting a range of measures that recognised the intrinsic value of the surrounding landscape and habitats. These included progressive landscaping and restoration to achieve natural landforms, the protection of existing sites of special scientific interest (SSSIs) and the minimisation of impact for local communities.

Although the ultimate aim of this work was to protect existing operational capacity, much value for future environmental management work derived from the process of developing the application. In particular, the company learned that work needed to be appraised across a broader range of environmental criteria that embraced the perspectives of other stakeholders. It is suggested that this may have contributed towards a new, emerging environment/ operations relationship.

(Sources: *fn 27.2.97; 28.2.97*; Transcript # 7, 9, 16; ECC, 1997; DOE, 1991).

Box 8.1: The Gaverigan Tip

The evidence from interviewees and the reflections of staff on the Gaverigan application, pointed to a progressive change in the way the company was viewing its relationship with the natural environment. There also appeared to be an understanding that practices and decision-making frameworks had to evolve to accommodate environmental interests in a more proactive manner.

8.5.3 Practical Realities

The company's new strategy and developing activities in the area of environmental management pointed towards a growing intellectual capacity for positive environmental change. It is important to observe, however, that these strategic intentions could be hampered by the practical realities of managing and regulating an industrial process. Of particular difficulty at ECC was the ongoing problem of burst pipelines. This issue is outlined in more detail in Box 8.2.

Pipelines: Issue Brief

Pipelines are used by ECC to transport clay slurry between the pits and the refiners, and between the refiners and the drying plants. With the Cornish operations covering some 25 square miles, clay can travel considerable distance in this fashion. The growth of the industry and the changing landscape and infrastructure has meant that over time the exact location and routing of many pipes has been lost.* As a result no complete record exists of pipe location.

During the study several managers described how, ageing and worn pipes were leading to an increased incidence of pipeline burst or leakage. Leaking pipelines would seep gradually, with clay eventually emerging at the surface. Breakages it was explained, were usually detected when either a) the workers on the landing lines (who controlled the receipt of the clay) reported that the slurry had not arrived or b) a member of the public reported a breakage. A 'typical' incident, recorded during a period in the field, took the following path:

- a burst pipeline was reported by a member of the public on a Saturday evening;
- this pipe was not repaired until the following Monday evening because suitable equipment was not available on site;
- the pipeline was one of four running parallel on a particular route which made access and repair difficult;
- at the time of the breakage, clay of SPSS grade was being discharged at 200 tonnes per minute;
- this resulted in the local road being covered with slurry;
- slurry was also channelled into a water course, from where it flowed downstream to the sea;
- one of ECC's environmental officers was cautioned by the Environment Agency at the scene and informed of the Agency's intention prosecute.

The company's reluctance (at the time of this incident) to address this issue with some urgency, was lamented by one member of the EMS team. In their opinion these incidents could act as flashpoints for public complaint even though the potential for actual environmental harm was

relatively limited. This inaction was also surprising both in the light of the new strategic approach to environmental issues, and with respect to one senior manager's comment that in the previous year incidents of this nature had cost the company £30,000.

*Towards the end of the study a team was established with a remit to trace and map pipeline routes

(Sources: fn 31.10.97,19.6.98, 20.7.98)

Box 8.2: Pipelines: Issue Brief

These difficulties suggested that the management of incidents, and the day-to-day practices on site, could run counter to policy claims and strategic intention. This supposition was confirmed by two operations managers who noted that:

> "More time is spent rectifying this environmental problem [pipeline bursts] than it is on setting up programmes to prevent that ... it is very much a breakdown sort of a system." Transcript # 11
>
> " Basic pipeline failures are a major problem, we have them all the time, It's at least one a week ... yesterday it went through someone's garden." Transcript # 10

This evidence shows the difficulties inherent in working towards new policy aims with existing frameworks and incomplete practices. Importantly, it also indicates how positive gains made in one area of environmental activity, can easily be undermined by smaller scale, but repetitive negative incidents.

8.5.4 Summary

On balance, the data presented in this section suggests that the company had made significant advances in redefining its relationship with the natural environment. This it is argued was occurring at a strategic level and was also evident in the growing intellectual capacity of the staff I spoke to during the study. The experiences gained whilst dealing with the Gaverigan tip application are illustrative of a learning curve that advanced the company's understanding of, and engagement with, 'planning for the environment'.

The practical difficulties of dealing with the pipeline issue show how even with strategic intent, good practice can be absent at ground level. This issue also illustrates how a

'bundle' of factors (historical practice, planning, new strategy and practical reality) can impact on the company's ability to manage the operations/ environment interface.

8.6 Relationship with Stakeholders

8.6.1 Background

In chapter three (section 3.6.2) I presented and discussed arguments which suggested that engaging with stakeholders in a proactive manner can bring important benefits for firms. In particular, it was reasoned that dialogue has the potential to reduce conflicts and can also spark a learning process within the firm that builds an institutional context supportive of environmental concerns (Fineman, 1996b).

In chapters five and six the contextual material presented, illustrated how the broader environment in which mining takes place has changed. I have shown that mining is now much more closely regulated both within the legislative and planning frameworks, and importantly, by the social changes that have taken place in the region over recent years. Here, changing demographics have brought a more diverse local population into closer proximity to the mining operations (discussed in chapter five, section 5.7.1). As a result, the company has arguably had to consider and address the relationships with a range of its key constituents more carefully.

Similarly, the analysis in chapter seven focused in on the interactions between ECC's environmental project research team and its key paper customers. In particular, the emergent themes highlighted the importance of communication and a close working relationship with customers throughout the life-cycle of any project to ensure commercial success.

In the following sections I consider more closely the nature of these relationships through key illustrative themes as they emerged from the data. In the first three sections the analysis is framed by the environmental management programme embedded unit, and relates to stakeholders in the operational environment. The analysis in the forth section deals specifically with the company's relationship with its

paper customers and is framed by the second embedded unit, the environmental research projects.

8.6.2 Increased Communication and Dialogue

Early fieldwork conducted during the study, pointed to significant challenges for the company in terms of communicating environmental information effectively. For a large proportion of its history ECC had benefited from being surrounded by a local population that either worked for or was connected with the activities of the company. However the social changes detailed in previous discussion had altered the support for and crucially, an understanding of, the company. Although company literature and public relations documents could be seen to be going some way towards informing the local stakeholders of environmental change, significant gaps in perception and understanding remained (Transcript # 7, 12).

Analysis of the interview transcripts suggested that there was a growing and pervasive awareness amongst operational managers of the need to communicate more effectively with the local community. As the comments below illustrate, this awareness in itself was a progressive change.

> "We communicate with them [the local community] now, that is certainly a change from the way we used to do things." Transcript # 19

> "You've got to work with local people, you can't just bulldoze things through ... you could be doing a brilliant job but if you haven't managed the information in the right way then people's perception of you could be that you are awful." Transcript # 9

> "There are tentative beginnings of trying to get out there [into the community] and to communicate before the event [an environmental incident] rather than when the complaints come in." Transcript # 7

That effective communication and importantly education, could allay some the potential misperceptions and complaints, was high in the consciousness of operations managers.

> " We need to have an understanding of what we are all about. A lot of people don't have an understanding of what we are all about any more and that is our fault." Transcript # 15

Increasingly, some managers were beginning to witness the benefits of opening up channels of communication, with both the local community and the regulator.

> "We now [having made the effort] have a very good relationship with the local people. I had a tip-off from one of the guys on the local council about dust, which meant that I was able to address it before it became a problem." Transcript # 17

> " I think the incident reporting [a mechanism to report environmental incidents, e.g. of a discharge consent breach] is proactive. We are dealing with it and we are involving the EA [Environment Agency]. If there is a major incident it is now a matter of course that the EA are informed." Transcript # 19

Crucially though, what was beginning to emerge as a result of these more proactive practices was that stakeholders with whom the company has previously experienced difficulties, were beginning to engage in more constructive dialogue.

> "They have made an effort to understand our problem, instead of just sitting outside the fence and trying to regulate. They now actually come into the company and try and understand why we have done things and why we don't always get it right, and why we sometimes want to resist." Transcript # 19

According to a senior manager, this more receptive stance was also starting to assist the company in its relationship with the Mineral Planning Authority (MPA), which as I showed in the 'Gaverigan Tip' example, had in recent years been a difficult area of negotiation for the company. By engaging in dialogue before developing tipping proposals the company could be seen to drawing clear benefits.

> "Talking to the planners now, we say, 'what do you want' and the planners have really taken to this and now they do see it very much as we would like to and we work together. There is tremendous amount of co-operation coming down from the planners and the local councillors and we are really starting to understand each other." Transcript # 14

This perspective was confirmed by a member of the EMS team, who reflected that the more open and inclusive approach being adopted by the company, had brought new opportunities. However, this view was also tempered by an understanding of the demands brought by closer working relationships.

> "We are able to work more closely with organisations which perhaps we wouldn't have been able to previously ... You ask for a response from the local community and you hold yourself up as responsible, then you find that you can't ignore the response that you get. So in some respects asking for responses from the community is positive, in that you manage to establish a relationship, but it does put a very big demand on the organisation." Transcript # 7

In spite of these difficulties the data illuminated a more positive and progressive stance being adopted by managers. This observation was particularly important because it was here at site level where some of the key conflicts could be seen to arise.

8.6.3 Impacts of Raised Awareness

The move towards greater communication and openness with local stakeholders had, in the view of most managers that I spoke to, been a necessary change that had brought advantages, particularly at the strategic, planning and regulatory interfaces. There was, however, some evidence that an improved understanding of company activities could bring greater scope for expressions of discontent, even among employees. As several managers pointed out:

> "People won't put up with dust these days, even the employees won't." Transcript # 18

> "Now people who work for the company will complain against the company and that has been a change." Transcript # 1

> " The workforce, a lot of them are concerned about the environment now, and if we started to do something a bit iffy, then they would be the first, knowing what they do now, to point the finger and complain." Transcript # 9

A greater willingness to complain was also observed in relation to some elements of the local community. Some managers in particular felt that these complaints came disproportionately from local residents who they classed as 'incomers' or 'foreigners', that is, any resident who was not born or brought up in the area.

> "It is whether people are starting to realise, 'hang on we don't like that' but we seem to be getting more and more complaints about a range of issues such as floodlit working." Transcript # 19

> "Of the complaints that I have had in the last twelve months I would say that four of those five were from what I would class as 'foreigners' ... they come down and cause more havoc than anyone." Transcript # 16

> "We do have neighbours who have very little to do with ECC ... people are obviously not going to be so tolerant if their husbands are not working for ECC." Transcript # 11

More informal conversations with managers showed this view of 'incomers' being the greatest complainants, to be widely held. However, for the most part, managers were only able to offer anecdotal evidence to support this view. This suggested that the

changing relationship with local people was perhaps more closely linked to the broader contextual factors considered previously, rather than residents' origins or affiliations to the company.

8.6.4 Policy Directions

It was interesting to observe that these interactions with the community or other interested parties caused some managers a great deal of concern, and approaches varied considerably. While most managers were in agreement on the necessity of communications with the Environment Agency, there was less consensus on how local community issues, which also included project work and funding, should be dealt with. Investigation of company practice showed that in spite of the growing demands and pressure of community liaison on managers' time, the company had no agreed policy on how to deal with these issues. This lack of policy direction clearly brought difficulties for managers and meant a heavy reliance on individual discretion, as this range of comments from both operational managers and environmental team members illustrates:

> "There is nobody [from a central position in the company] saying in detail what we should do in terms of dealing with the community." Transcript # 17

> "There's no written procedure, there's no company policy, not that I'm aware of anyway, that says local management are responsible for that [dealing with the local community] ... I've got enough to worry about quite honestly." Transcript # 10

> "There has been no clear plan [of how to manage the changing relationship with the community] ... it has been left to the individuals who are front facing ... and there are a lot of us who are." Transcript # 9

> "The pressures, they tend to be very individual and very personal." Transcript # 13

> "Up until very recently we have had individuals responding to individuals [about complaints or environmental issues] there has been no best practice." Transcript # 7

Interestingly, while senior managers recognised that this lack of best practice or policy guidance was an issue there appeared to be no immediate plans to rectify the situation. This was in spite of the fact that it was an obvious and increasing drain on managerial time. As one senior manager reflected:

> "We don't have a written policy, we have an unwritten policy that says we support local community projects, particularly in the china clay villages, but not on a large

> scale. We make donations that add up to about £200,000 per year and they are fairly well spread around... [between the sites and managers]. But there is no overall appreciation of what the money does and therefore we are critiqued for not doing enough. We really should perhaps have a clearer definition of what we do." Transcript #12

These comments suggested that although the company had begun to address the need to communicate more effectively with its local stakeholders on environmental issues, it had yet to place this work in a policy framework that dealt with community relations more broadly. As a result managers were working largely on an individual basis which inevitably was leading to variable practice across the different sites.

8.6.5 Knowing Your Market

For ECC, the challenge of developing and commercialising their environmental projects revealed some of the difficulties, as discussed previously, of establishing a closer relationship with the paper mills. The initial ideas for the projects (as indicated in chapter seven, section 7.2.2) were founded largely on the experiences of a small number of scientists and their perception of the key issues as expressed by their mill contacts.[1]

> "The idea [for rECClaim™] came from our early meetings with customers when there was this horrendous talk of limiting the amount of mineral in paper ... all the problems came from the mills they said we have a huge problem and we don't know what to do.' Transcript # 30

> "It's wrong now, but at the time the message was pretty consistent ... it was very much we are all expecting that production in the future is going to be measurably affected by legislation." Transcript # 22

The analysis in chapter seven revealed that these links were established through several key individuals, who had both a keen interest in environmental issues, and existing close relationships with senior personnel at a number of major Scandinavian paper mills. However, as indicated, when these people were lost from the projects the links were also diminished. Additionally, as the projects progressed, facets of mill behaviour that had not originally been apparent came to light, in particular, their conservative investment tendencies when faced with new relatively unproven technology (Transcript # 23).

[1] As well as the technological know-how available within ECC"S research team at this time.

These observations of company experiences suggest that although ECC had good existing relationships with mills with respect to mineral and pigment sales, they were not appropriate for the inherently closer working that was required by the environmental technologies. In particular, the cumulative experiences of the company that emerged through the key themes in chapter seven, suggested that the company did not understand the market for environmental technology sufficiently well.

This was highlighted by comments from several scientists who had observed that although paper mills respected ECC as a pigment provider, the company lacked the credibility (in technology) that paper mills demanded to be confident of their investment (Transcript # 25, 26).

8.8.7 Summary

The analysis in this section has shown that in an operational context the company had begun to make significant strides towards placing its relationships with key local stakeholders on a new footing. A more positive approach with both the regulator and the local planners was deemed to be bringing benefits. Some difficulties were still apparent and this situation was (at the time of the study) not being assisted by the notable lack of any over-arching community liaison policy.

Relationships with customers with regard to the environmental projects had demanded a steep learning curve for the company. It is argued that although the company was confident in its position as a pigment seller, it had not established sufficient credibility to market the environmental technologies successfully.

8.7 Chapter Summary

This chapter has explored the propositions developed in chapter three which suggested that key factors internal to the firm can act as moderating influences on the development of the environmental capabilities pollution prevention and clean technology. *Non-environmental strategies* were argued as being key to the development of both capabilities. The data showed environmental management work competing with the CPI initiative for financial and human resources, which meant that

the environmental initiative was afforded substantially less strategic priority and concomitant practical resources. The impact on worker morale created a 'knock-on' effect experienced by EMS team. Environmental innovation project work was also squeezed by the concomitant organisational initiatives, but was seen to draw some benefits as a result of more progressive management approaches.

The company's *track record on environmental issues* was observed as having had a significant impact on current operational practices. Evidence of past work practices which did not meet current environmental standards was identified although there was substantial evidence of changing attitudes that were leading the company towards a more compliant operational regime. Reflections on the company's *experience with innovation* showed that past practices had been dominated by 'technology-push' which was largely inappropriate for environmental innovation, and arguably, elsewhere in production innovation generally (Rothwell, 1992). Interestingly though, there had been little attempt to address these inadequacies and environmental work had been pursued along traditional lines.

The chapter also analysed in more detail evidence relating to the propositions that the character of an organisation's relationship with its stakeholders, and between its operational activities and the environment, can influence the development of environmental institutional capital. In considering *the relationship between operational activities and the natural environment* important and progressive changes in strategic policy directions were identified. These changes provided evidence of a more established and accepted role for environmental work in the organisation, as exemplified by experiences surrounding the Gaverigan Tip planning application. These positive changes were, however, tempered by some practical operational difficulties, as illustrated by the ongoing challenge of dealing with pipeline bursts.

The *relationship with stakeholders* could be seen as being increasingly key to the successful delivery of environmental management and innovatory projects. For environmental management in the operational environment, the company had seen benefits from improved communication and education initiatives for local stakeholders that had served to support work in the context of the EMP. In contrast, the cumulative evidence relating to the environmental projects suggested that relationships with

customers were more fragile. This presented particular difficulties, as the environmental projects demanded a closer working relationship that was hampered, in part, by questions surrounding the company's credibility as a provider of environmental technology.

These findings have implications for the development of the capability contributing resource characteristics, considered in chapters six and seven. These issues together with those explored in the previous analysis chapters are drawn together for consideration in chapter nine, which reflects on the evidence presented from a pragmatic and theoretical perspective.

Chapter Nine: Summary Discussion

9.1 Introduction

This thesis has sought to explore the central theme, introduced in chapter one, of how firms undertake the development of environmental capability. Analysis of the extant literature identified a number of key theoretical areas and methodological openings to progress work in the field (chapter two, section 2.12.3). Accordingly, I constructed a series of propositions and a conceptual model (chapter three, section 3.7) designed to investigate the development of environmental capability in some detail. I proposed that the key resources, which authors have hypothesised as contributing towards environmental capability development, are actually composed of a series of resource characteristics. I suggested that firms need to be able to demonstrate these characteristics in order to progress environmental achievements. In addition, I argued that the development of these characteristics (and hence key capability development) may be moderated by a number of factors internal to the firm. In this case I identified and investigated three pertinent factors (non-environmental organisational strategies, track record on environmental issues and experience with innovation).

Significant to the study was the introduction of organisational context, through which key factors may enhance or inhibit the development of an appropriate institutional setting argued as being supportive of environmental capability development. Two key factors drawn from extant empirical studies (the relationship with stakeholders and the relationship between company operational activities and the natural environment) were considered in this case. The empirical investigation of the research propositions adopted a pragmatic stance, employing a case study strategy with embedded units of analysis. Mixed methods were used, with data derived primarily from interviews and a questionnaire, supported by observations and secondary data gathered in the field. In chapter five I discussed key contextual issues which provided the foundations for, and contributed to, the case analysis. Chapters six, seven and eight drew from the full range of data sources to present a detailed analysis of the study findings.

In this chapter I draw together the analysis themes presented in the preceding chapters through a summary discussion of the findings. In particular, this discussion addresses the two sub-themes introduced in chapter one, which asked:

- *What are the necessary building blocks for the development of appropriate environmental capabilities?*
- *To what extent is this development process influenced both by other factors internal to the firm and by immediate organisational context?*

The following sections, therefore, consider in turn what the findings say about the ability of the case company to demonstrate the identified resource characteristics, and the relative influences of the moderators and the selected elements of environmental institutional capital investigated by the study. The discussion also reflects on the value of the conceptual model (introduced in chapter three, section 3.7) as a research tool. I consider how, on the basis of the findings in this thesis, it may be adapted and applied in future research in the field of environmental capability. The implications of this discussion, which embrace the contributions and limitations of the thesis, are reserved for the final chapter. Chapter ten also points to further research directions based on the study findings. This chapter concludes with a brief summary of the key discussion points.

9.2 Evaluating the Findings

In chapters six, seven and eight I analysed and discussed at length the evidence gathered pertaining to the four sets of propositions. The analysis drew on the full range of data collection techniques employed and provided both a broad and a detailed picture of environmentally-related practice and policy development in the case company. In particular, the evidence presented was characterised by a series of emergent themes. These themes, which are summarised in Figures 9.1-9.4, can be classified according to their largely positive or negative influences on the empirical units being investigated. In the following sections I draw together the evidence captured by these themes and consider to what extent the concepts embraced by the propositions may be demonstrated.

9.2.1 Resource Characteristics: Pollution Prevention

The discussion in chapter three argued that pollution prevention should be considered a key capability in the development of environmental capability in the firm. It was illustrated that pollution prevention is particularly relevant for mining companies whose operational activities are inherently linked to the natural and social environment.

The analysis suggested that pollution prevention may be distinguished by five key characteristics, total quality management, 'green teams', employee involvement, environmental awareness and environmental values. Figure 9.1 below, summarises the key themes presented in chapter six that emerged in this case as relating to the resource characteristics conceived as underlying a pollution prevention capability. The Figure shows that, for the most part, the characteristics investigated were subject to a series of opposing forces which were serving either to enhance or detract from the establishment of the proposed characteristic. The following discussion reflects on these findings from both theoretical and practical perspectives.

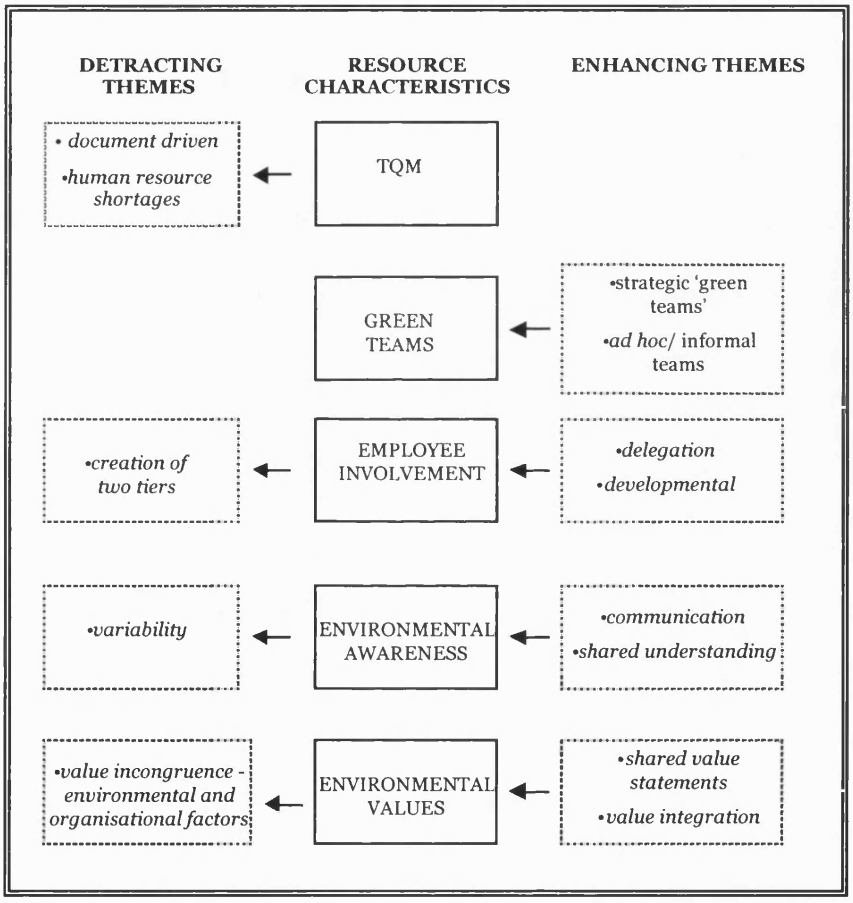

Figure 9.1: Summary Themes: Resource Characteristics – Pollution Prevention

Section 3.3.1 of chapter three introduced the proposition that *Total Quality Management (TQM)* may be a key component of the environmental capability pollution prevention. TQM was outlined as a dynamic management approach that aims to

integrate the different elements of an organisation in such a way, that the delivery of consistent and improving quality, is enhanced. This approach, it was suggested, has clear synergies with the objective of delivering improved environmental performance. More specifically, authors have argued strongly for the establishment of TQM practice to support the development of a pollution prevention capability (Hart, 1995). The analysis in chapter six (section 6.3) indicated that the existence of TQM practice in this case, was weak. The evidence pointed to limited aspirations at a strategic level to pursue total quality objectives from either a practical or a philosophical standpoint. As such, little evidence was available to support a progression for the company beyond the more static conceptions of quality that researchers argue can become associated with quality systems (Street and Barker, 1995). This situation was exacerbated by low levels of organisational slack in the company as characterised by the human resource shortages experienced by staff working with a quality remit.

Environmental management texts and previous conceptions of the relationship between TQM and improved environmental management invariably assert that TQM is incremental to environmental improvements (Hart, 1995; James, 1996). Hart (1995) in particular, argued that there was both a path dependency and an interconnectedness between characteristics such as TQM and the development of environmental capability.

What I have shown in this case, is a situation where a combination of past practice (as exemplified by organisational structures and culture) and the pressures of contemporaneous organisational initiatives, has resulted in an environment that is not sufficiently adapted to support the more devolved working associated with TQM. This continued to be the case during the study period, even though organisational changes were driving towards the greater empowerment of staff as well as the use of teams, that theoretically would favour, and have distinct synergies with, the emergence of TQM practice (James, 1996).

Significantly, in this case, progression towards TQM objectives was being hampered by the detracting themes illustrated in Figure 9.1. It is important, therefore, to be aware of the argument supported by some authors (Welford, 1993), that TQM principles cannot necessarily be successfully or appropriately applied in many organisations if an underlying commitment to changing organisational values is absent (James, 1996). The

difficulties identified in this case, suggest that a TQM approach requires a particular set of foundations (including flatter structures and a new human resource approach) to support the development of a management system. This is a view supported by Powell (1995), whose study showed that successful TQM development depended critically on the intangibles of senior commitment, open organisation and employee empowerment. At ECC the move toward developing a more progressive management structure and organisational culture was still filtering through the organisation and, in the areas examined by the study, previous hierarchical and bureaucratic influences remained. This suggests that further research is needed to examine whether TQM is in fact an appropriate, or useful, indicator of environmental capability development in organisations with more 'traditional' or changing management structures and practices. The findings in this case point to the need for research that examines these links specifically, across a range of different managerial structures.

The discussion in chapter three (section 3.3.2) proposed that *'green teams'* may be able to make valuable contributions to the development of environmental capability. In particular, the analysis suggested that teams could act to break down existing organisational rigidities that may hinder new, environmentally progressive measures. In this conception, 'green teams' share some of the developmental qualities of the TQM characteristic. Interestingly, therefore, the findings showed that, in contrast to the evidence presented for TQM, 'green teams' were increasingly being used as an efficient and more effective mechanism for delivering environmental improvements and meeting environmental targets (chapter six, section 6.4). The data showed teams being employed and operating at a number of levels, both permanently to steer strategic issues and as short-lived mechanisms to tackle immediate environmental concerns.

Importantly it was observed that team working in general was a positive spin-off of the broader organisational changes taking place (chapter eight, section 8.2). That is, a more 'open' management style appeared to pushing an acceptance and application of team working for environmental benefits. The evidence showed managers increasingly drawing on and applying their new skills in the context of the environmental management programme. As a result I would argue that the organisation's ability to demonstrate this characteristic was enhanced. That synergies may be drawn from other organisational initiatives finds resonance with recent work by Christmann (2000) who

argues that in an environmental context, firms may draw benefit from 'complementary assets' developed in the course of other productive activities. In particular, this author states that:

> "Because they play a central role in a firm's business strategy ... [these assets] are available to be leveraged in the firm's environmental strategy" (Christmann 2000, p. 667).

Crucially for environmental management practice at ECC there were also clear signs from the data, that work being undertaken, for example, by the audit teams was resulting in direct environmental improvements at site level (through basic housekeeping and better waste management practices). Cumulatively, therefore, the evidence pointed towards the existence of 'green teams' as being an important indicator in the development of environmental capability, supporting the theoretical conception that this was a valuable underlying resource characteristic. Further, I would argue that in this case, 'green teams' were a powerful driving force in terms of pushing ECC beyond the 'compliance' paradigm.

The analysis in chapter three (section 3.3.3) argued for a more participative approach to environmental management that stems from engaging and involving employees in improvement initiatives. The proposition that this approach may enhance the development of a pollution prevention capability was supported by extant cross-sectional empirical data. *Employee involvement* was shown through the data analysis to be an emerging area of environmental practice in this organisation. As I identified in relation to the development of 'green teams', practical approaches and strategies for involvement appeared to be drawing impetus from the complementary work being undertaken through another organisational initiative, Investors In People (IIP).

The discovery of mixed perceptions with regard to the value and opportunities brought by the strategies for involvement (chapter six, section 6.5) supported the observation made by Denton (1996), that managers and workers may see the motives for involvement differently. In this case, it was apparent that managers were (in the context of human and capital resource shortages) making the most efficient use of existing employee skills and expertise in order to meet environmental targets. However, there was also an awareness amongst these same managers, that the availability of opportunity (to become involved with environmental work) was not always equitable.

The enthusiasm of production workers in particular to become involved with environmental work, meant that this situation needed to be carefully managed so that the momentum gained by involvement strategies was not lost.

Importantly for the development of the literature in this area, the findings also provided the case-level empirical detail indicated by Ruiz-Quintanilla et al (1996) (chapter three, section 3.3.3), as being necessary to establish that employee involvement can indeed bring benefits to pollution prevention activities. Examples in this case included the more proactive response by employees to incidents of fly tipping on company sites (chapter six, section 6.5.3).

On balance, the evidence indicated a growing capacity in the case company to demonstrate this resource characteristic, and importantly for improved capability development, the results could be tied to minor, but incremental improvements in environmental performance based on practical activities, particularly at site level. Crucially for ECC, it is at this level that many of the key environmental issues associated with the mining process need to be addressed, and is where evidence of pollution prevention activity is required (for example, by the regulatory authorities) in the first instance. These findings therefore supported the theoretical conception that employee involvement was a valuable underlying resource characteristic.

Although not directly explored in the study, it was observed that the improved motivation of employees to be involved with environmental management work appeared to coincide with the stronger, and more consistent, message being delivered by the company following the launch of the strategic Environment, Safety and Health (ESH) policy in 1997. The data revealed employees approaching the environmental team on their own initiative following the announcement of the ESH work. This postulated link between policy commitment and employee involvement, was illustrated in a recent study by Ramus and Steger (2000). These authors showed that, in their study, having a convincing company environmental plan tripled the probability of employee ecoinitiatives because employees were able to draw direct links between their efforts and policy commitments.

Environmental awareness was proposed in chapter three (section 3.3.4) as being the cornerstone of any environmental management programme. This view was supported by extant empirical work, which pointed to the necessity of basic environmental awareness for employees, in order that they may contribute more effectively towards environmentally beneficial practices (Halme, 1996; Christie et al, 1995). Analysis of the findings in chapter six revealed variable levels of environmental awareness both within and between the different organisational hierarchical layers. A needs analysis undertaken by the company, had suggested the importance of operational level workers having a basic understanding of environmental issues, but the findings pointed strongly to the difficulties of communicating the appropriate message effectively, especially where senior management were faced with time constraints (chapter six, section 6.6).

Significantly, while employees appeared to share an understanding of basic environmental impacts on the physical media (air, land and water), there was less evidence of this knowledge being applied to an understanding of impacts, for example, in the social or cultural environment. This was an important observation for this company where environmental management activities in the operational environment needed increasingly to take account of the more subtle and subjective issues associated with long-term land planning, as occurred in relation to the Gaverigan Tip application (chapter eight, section 8.5.2). At a practical level this pointed to a requirement for a more holistic environmental education programme that could focus on making more explicit, the links between physical environmental impacts and the social impacts of mining activity. The inconsistencies in awareness revealed by the findings suggested that it was difficult for the company to demonstrate a solid grounding in this resource characteristic.

Importantly, for the progression towards environmental improvement, this variability was also evident in more senior staff (chapter six, section 6.6.2) who as Sharma (2000) argues in a recent study, act as the 'interpreters' of environmental issues. These interpretations are driven by individual assessments of issue legitimacy (Dutton and Duncan, 1987). In this case it is argued that environmental issues had yet to achieve parity with other business concerns. This related in part, to the turbulent nature of the company's core business at the time of the study. Additionally, managers tended to frame environmental concerns through a 'risk' paradigm where action was most likely

when direct impacts on the company's financial bottom line could be demonstrated. In other words, I would argue that awareness of the issues had, for some managers, yet to translate into a deeper level of understanding relating to how environmental concerns could impact core business activities both immediately and in the long term.

As noted in earlier discussions of the findings, awareness training was at an early stage of development at ECC and it was, therefore, arguably too early to make links between these changes and potential environmental improvements. Nevertheless it is argued on the basis of the broader findings from the case, that the characteristic of environmental awareness should be considered an important indicator for environmental capability development, supporting the conceptual basis for the proposition.

In chapter three I introduced *environmental values* as being a potentially valuable resource characteristic underlying the development of a pollution prevention capability. Drawing on the work of Welford (1997), Hoffman (1993) and Dodge (1995), I suggested that organisations are more likely to see environmental improvement where individual and organisational environmental values exhibit parity. Analysis of the findings relating to environmental values uncovered a range of perspectives (chapter six, section 6.7). Responses to a series of organisational value statements indicated a strong and positive environmental ethic that varied little between the functions and hierarchies. This evidence was surprising as I would have expected to see differences based not only on *a priori* theoretical reasoning (discussed in chapter three) but also on the supporting data that showed, for example, significant variations between the hierarchies and the functions in the linked characteristic of environmental awareness. Additionally, the qualitative data gathered, which considered the extent to which environmental values had become integrated into existing organisational culture, revealed a more varied and at times sceptical response from interviewees. It is suggested that the quantitative findings may reflect a degree of strategic responding by employees 'second guessing' what they considered to be the 'right' answer, rather than a true representation of their values on these issues. This is a necessary qualification in the confidence of the findings and reflects the weaknesses inherent in any self-report data collection method.

Interestingly, therefore, although the data pointed to some degree of congruence between personal and corporate environmental values, a broader assessment of the

findings showed a varied picture suggesting a more 'patchy' demonstration of this resource characteristic. In particular, the analysis revealed significant differences between personal and perceived corporate values across a spread of factors (for example employee safety, community relations, environment and profit - see chapter six, section 6.7). As Hoffman (1993) proposes, these differences could, in this case, be seen to be creating internal tensions, which in some situations were leading to poor environmental performance. For example, employees expressed concern that their personal environmental values sometimes came into conflict with the operational requirements of production goals (*qn 133*). By placing employees in a situation that required them to behave in ways that were inconsistent with their personal characteristics, the organisation was in danger of contributing to some of the low morale issues identified by the study (chapter 6, section 6.5.1 and chapter eight, section 8.2.2). This suggested a need for ECC to obtain a more detailed understanding of its employee environmental concerns, in order to channel those commitments positively for environmental benefits.

While the findings allude to the inherent difficulties of measuring and interpreting individual and perceived corporate values, they also suggest strongly that the proposed relationship embraced by the research propositions is supported. In particular, my experiences throughout the case of environmental activity at a site level, pointed to the best examples of improved environmental performance being associated with managers and environmental co-ordinators, who expressed strong personal environmental values.

9.3.2 Resource Characteristics: Clean Technology

The discussion in chapter three highlighted the value of a clean technology capability in the extractive industries, where companies are under increasing pressure from a range of stakeholders to improve environmental performance. Specifically, the analysis in section 3.4 proposed that three key characteristics (cross-functional working, Design For the Environment and Life-Cycle Assessment, partnerships and collaboration) underlie an organisation's ability to produce cleaner technologies that generate less waste and pollution. Figure 9.2 below, summarises the key findings, presented and discussed in chapter seven, that relate to these three resource characteristics. The evidence suggested that the establishment of the three characteristics investigated, was hampered by a range of factors. These factors reflected the past strategies and working practices in the company. The key findings are outlined below.

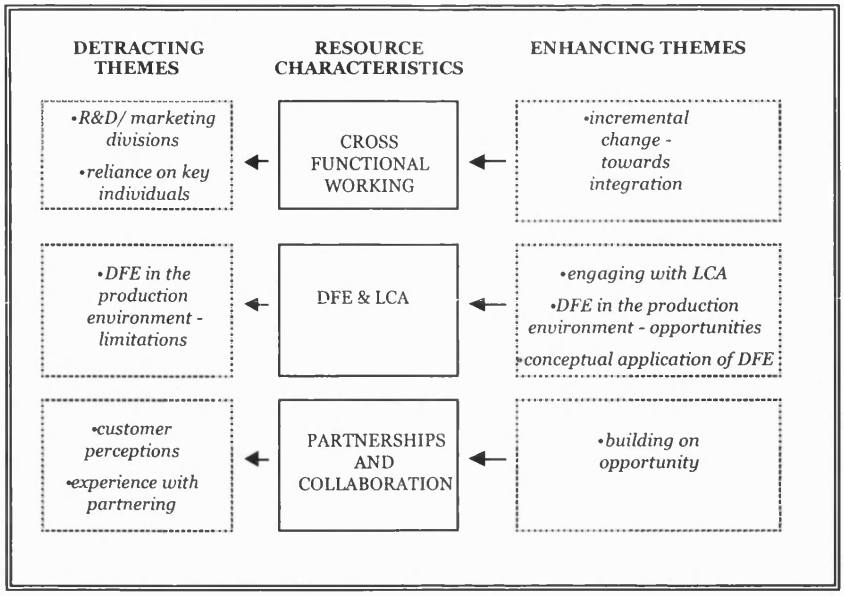

Figure 9.2: Summary Themes: Resources Characteristics – Clean Technology

In chapter three (section 3.4.1) I proposed that if a company were able to demonstrate the characteristic of *cross-functional working* then this could contribute positively to the development of a clean technology capability. To support this proposition I drew on arguments made by researchers (Groenwegen and Vergragt, 1991; Winn and Roome, 1993) that this specialised form of team working is particularly valuable in the context of environmentally-related research and development (R&D).

Analysis of ECC's ability to apply cross-functional working revealed a complex set of factors at work that appeared to relate to historical regimes and patterns of innovation activity in the company. Of particular importance in this case were the sustained divisions between the company's marketing and research personnel. This intellectual and physical (location) separation of the two functions militated against integrated developments and commercialisation throughout the life-cycle of the environmental projects (chapter seven, section 7.3). These factors, together with a tendency toward isolated research practices, saw valuable tacit knowledge restricted to a number of key individuals.

The analysis in chapter seven argued that the company had followed dominant regimes because they had served innovation activity well in the past. Studies in innovation

frequently point to a path dependency (Clarke and Pitt, 1996), which Hart (1995) also applies in his conception of environmental capability. Authors argue that organisations choose to ground new innovations on the basis of existing experience, built over time along specific trajectories. In this instance it was demonstrated, as Winn and Roome (1993) hypothesise, that existing organisational structures and past practices do not necessarily serve the new demands encountered by environmental innovation well. The evidence showed that there was little attempt to employ a multidisciplinary approach when developing the environmental projects. As a result, the marketing element of the innovation process suffered. Therefore, even with the incremental company reorganisations that were working towards using team-based structures (demonstrated primarily by the US side of the business toward the end of the study period), the organisation was not able in this context, to demonstrate a strong characteristic for cross-functional working.

Importantly though, although the characteristic could not be comprehensively demonstrated, I would argue that it be considered a useful empirical indicator in this case. The evidence provided strong support for the assertions made in chapter seven that a lack of cross-functional working contributed significantly to the commercial difficulties encountered by the environmental projects.

Life-Cycle Assessment (LCA) and Design For the Environment (DFE), were introduced in chapter three (section3.4.2), as being conceptually linked. In the analysis I argued that the concepts and practices inherent to LCA and DFE provide the foundations for the establishment of cleaner technologies. Section 7.4 of chapter seven presented a spread of data which suggested that, the company had yet to realise the environmental (and possibly commercial) value of LCA and DFE practices in either the production or the R&D environment. In particular, the evidence relating to these characteristics provided a good example of a key reoccurring theme in this case. Specifically, the intellectual capital relating to the utility and possible application of LCA and DFE data resided in a limited number of key individuals.

For example, the analysis of findings in chapter seven (section 7.4.2) showed that during the latter half of the study, life-cycle inventory (LCI) work was being systematically undertaken to gather key information from the production environment.

However, because the strategic priority for this work was low, there were only a handful of personnel in a position to understand the potential for linking the findings (e.g. on water usage and monitoring) with the design of more efficient procedures. Typically, therefore, in this case, a knowledge and awareness of these techniques could be demonstrated (all be it in a limited capacity) but the practical and progressive application of these characteristics could not.

Similarly, whilst it was an intellectual conception of DFE (in the market environment) that had driven the development of the environmental projects, there was little evidence that these principles had been applied in the actual design of the projects themselves. Perhaps the best examples of DFE in action could be seen in the production environment where managers were embracing new, broader criteria when designing and commissioning new equipment (see chapter seven, section 7.4.3).

These are interesting findings, largely because the literature (Hart, 1995; DeSimone and Popoff, 1997) suggests that there is an embeddedness to the development of cleaner technologies. These authors imply that the development of these new environmental capabilities relies on other complementary resources being present. In this case, it has been argued that the foundations for improvements through pollution prevention were developing positively, and yet the evidence presented in this thesis for the clean technology resource characteristics, suggests that this company has not built progressively on these interconnected foundations. These findings point to a need for researchers to investigate further how capabilities hypothesised as being complementary in an environmental context, actually link in practice. In other words, is capability acquisition necessarily incremental or can companies leapfrog stages in the development process?

The analysis in chapter three (section 3.4.3) suggested that an increasing number of firms are seeking to engage in partnerships or alliances in order to realise a range of 'collaborative advantages' (Kanter, 1994). In the discussion I pointed to growing evidence from researchers (DeSimone and Popoff, 1997; Green et al, 1994), that environmental innovation activity, in particular, may benefit from companies building new relationships with partners. The presentation of the findings in chapter seven (section 7.2) showed how much of the stimulus for the development of environmental

projects came from existing relationships in the market place. As Green et al (1994) suggest, this represents one of the most important sources of innovatory ideas for environmental projects. Illuminating in this case, is the observation that these relationships were not cultivated throughout the development of the projects themselves. Rather, ECC concentrated on 'in-house' development drawing information and materials (e.g. mill waste samples) from the mills but not actively seeking co-operation with the detail of the technologies.

The evidence pointed to a lack of experience with closer working relationships. Therefore, even though recent organisational changes and trialling of the environmental projects had brought the development processes closer to the mills, the company were not able to demonstrate a strong characteristic for partnerships at the time of the study, (chapter seven, section7.5). These findings support the contention by DeSimone and Popoff (1997) (highlighted in chapter three) that many firms have yet to reach a point of constructive dialogue with their expanding range of stakeholders. Perhaps more significantly in this case, some firms have, to date, also neglected to consider the opportunities that may be available to them by re-examining existing relationships. At ECC it is argued that internal organisational factors (particularly residual organisational culture and strategy) created a preference for 'in-house' development and that this acted as a negative influence on collaborative working (Kanter, 1994). This is a key point as it provides empirical support for Montgomery's (1995) argument that resource-based approaches often neglect to consider or illuminate the resources that may have a negative impact on firm performance. While the company were able to build a technologically viable process, it was arguably the lack of a resource in partnering, which as Hart (1995) indicates, demands more socially complex skills, that militated most strongly against the commercial success of the projects. This evidence also supports the view that, while external influences are important, it is predominantly internal organisational factors that influence whether (and the extent to which) firms choose to collaborate (Kanter, 1994).

An examination of the 'enhancing themes' in Figure 9.2 reveals that most of these positive influences resulted from the very recent organisational changes that were progressively reconfiguring the company and the way it conducted its business. These changes included the introduction of 'stage-gating' to project development, licensing

agreements for the projects and a wider application of team working. Crucially though, in spite of the cumulative evidence pointing to a limited demonstration of the conceptualised resource characteristics, the company was still able to produce a technologically viable process (rECClaim™) that fulfilled the criteria for a 'clean technology' set by authors in the field (Clift and Longely, 1996). It may therefore be useful to consider not just whether a firm is able to produce a clean technology, but also whether that technology is commercially viable. Further, this leaves open the question of the extent to which the conceptualised characteristics are useful empirical indicators of the clean technology capability. I would argue that there may be a need to research more carefully 'how' companies have achieved environmental innovations to assess the role of the resources conceptualised as being important by authors (Hart, 1995; Clarke and Roome, 1995).

9.3.3 Moderating Factors

The introduction of moderators into the exploration of environmental capability represented a key development of this study. As noted in chapter three (section 3.5), other management theories have considered how additional factors internal to the firm may impact the strategy-performance relationship. However, few authors have pursued these ideas empirically from the perspective of environmental capability development with the recent exception of Christmann (2000) working on 'complementary assets'. Based on an analysis of the extant literature, I introduced three factors internal to the firm (non-environmental organisational strategies, track record on environmental issues, experience with innovation) which may act to moderate the development of the environmental capabilities considered in this case.

Figure 9.3 illustrates the themes that characterised the influences of the identified moderating factors in this case. Highly significant are the largely negative influences that emerged from the analysis of the findings in chapter eight, and that occur across all three factors considered in this study.

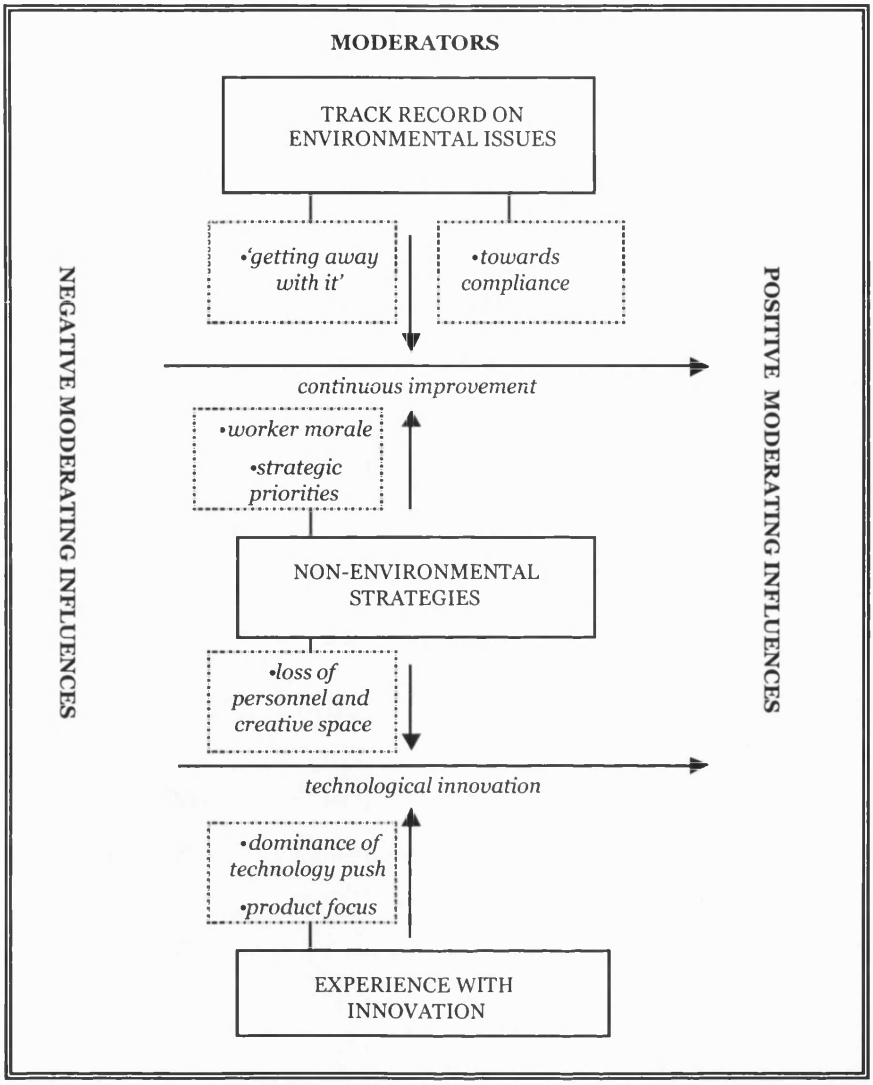

Figure 9.3: Summary Themes: Moderating Factors

I suggested in chapter three that many authors have framed environmental issues as *the* strategic issue facing businesses in the 21st century. While it may be possible to argue this view at a fundamental level, a more pragmatic perspective points to the need for research to focus on what companies actually do (in terms of interpreting environmental issues) in order to understand how they may integrate environmental strategies more effectively (Petts, 2000). Key to this understanding, is the need to consider environmental strategies in the context of other business approaches (as proposed in chapter three, section 3.5.1).

In this case, as Sharma and Vrendenberg (1998) suggest may be possible, other *non-environmental organisational strategies* were shown to be having a profound effect on the development of environmental work. In particular, the analysis showed that contemporaneous organisational improvement initiatives, significantly impacted the development of environmental management and innovation work (see Figure 9.3 for the summary themes discussed in chapter eight).

While there was evidence that benefits could be drawn where the different strategies worked in areas of synergy (see for example, the environmental efficiency measures achieved through the cost cutting exercises, described in chapter seven, section 7.4.2), it was perceptible from the analysis that environmental work was considered to be of less strategic importance. Although interviewees could frequently envisage the long term benefits of environmental management and project work, capital expenditure and the allocation of staff needed to 'stack up' against other work initiatives focused on delivering cost reductions.

In the context of difficult trading conditions and a turbulent organisational environment brought by restructuring, it was less surprising to see resources being redirected with, for example, staff on the environmental projects losing valuable 'creative space' (chapter eight, section 8.2.3). This finding, that the organisation was less likely to apply resources to environmental work in unstable market conditions, resonates strongly with Bowen's (2000b) assertion that the availability of organisational slack is closely linked to environmental responsiveness. In other words, even in large organisations such as ECC (where size alone, has in the past been considered a sufficient explanation for relative progress with environmental initiatives) there are more likely to be a complex interplay of factors at work, as illuminated throughout the analysis. Low levels of slack are therefore more likely to impact those strategies where there are less immediately identifiable short-term benefits.

In chapter three I introduced the notion that historical circumstances unique to the firm may influence the way it deals with contemporary issues. This conception was supported by evidence from researchers using a resource-based perspective (Teece et al, 1997). Specifically, I suggested that a company's *track record on environmental issues* may influence the way it approaches emerging environmental management and

innovation challenges. The evidence presented in this thesis showed that in this case, the company's track record on environmental issues continued to shadow contemporary activities with predominantly negative influences (in spite of the significant progress that had been made). Significantly, even though the evidence pointed towards changing practices (chapter eight, section 8.3.3) there remained a perception among employees (spanning a range of positions and functions) that the company was sustaining a largely reactive stance in the face of emerging environmental concerns. This, I have argued reflected both the power and historical influences of the company (explored in chapter five) and also a more generic, extractive industry, strategic positioning.

As indicated previously (chapter three, section 3.2) extraction companies frequently face an intractable set of environmental issues brought by the nature of their operational activities. This makes it extremely difficult for these companies to position themselves as environmental leaders. As Bansal and Roth (2000) note in their contemporary exploration of 'why firms go green' the motivation of firms in this position tend to be one of 'legitimisation' that will ensure survival (in the organisational sense) by protecting their 'licence to operate'. In chapter one I suggested that this represents an important strategic choice, and the findings in this case support this analysis. Typically ECC found that working towards compliance and lessening risk was a strategically and practically more attractive option, based on their largely reactive and autonomous working track record. It is suggested that the company's experiences to date had not served to either motivate or prepare ECC to develop more proactive environmental measures targeted towards either competitive or socially responsible ends. Rather the prevailing message was one of caution tempered with an acceptance of the need for greater transparency.

Section 3.5.3 of chapter three outlined how the processes of innovation are multifaceted. Drawing on the work of Winn and Roome (1993) and Kemp (1993) I suggested that the new technologies associated with environmental innovation may place additional demands on the innovatory capacity of organisations. As firms characteristically draw on their existing knowledge base to progress new innovation (Nelson and Winter, 1982), I proposed that a firm's *experience with innovation* may influence the future development of a clean technology capability. The evidence presented in relation to each of the resource characteristics, conceived as underlying a

clean technology capability, showed that in this case innovation appeared to occur in spite of, rather than because of, the proposed resources. These findings pointed to the possibility that an alternative factor, such as the firm's experience with innovation, may have been providing the necessary impetus.

In fact what the analysis showed was that existing regimes appeared to be exerting a 'brake' on the development of environmental projects, particularly when they reached the commercialisation phase (Maxwell et al, 1997). Crucially, the existence of a strong scientific and technological background had allowed the firm to generate the ideas and technology to build a technically viable process. However, this largely 'technology-push' linear process was not able to support the iterations and commercial responsiveness needed at the commercialisation phase (chapter eight, section 8.4.3). Without a clear, defined marketing approach, the company remained reluctant to actively push the environmental technologies in the marketplace (box 7.2, chapter seven). In reflecting on their experiences it was clear that managers were beginning to see how an interactive approach to innovation (Rothwell and Zegveld, 1985) would have been more appropriate for the environmental projects (see chapter eight, section 8.4.4).

It is argued, therefore, that in this case, past experiences acted as a negative influence with the company struggling to break the existing innovation mould (that related to mineral products and not to the more complex and technically demanding environmental processes). These findings support Kemp's (1993) argument that environmental work needs to be conceptualised differently along the entire innovation cycle.

9.3.4 Selected Elements of Environmental Institutional Capital

In section 3.6 of chapter three I incorporated organisational context into the analysis of environmental capability development. In order to do so, I operationalised work by Oliver (1997), who suggested that it is the context surrounding resources (in this case resource characteristics) that may enhance or inhibit their optimal application. In the discussion I proposed that firms need to cultivate 'environmental institutional capital' to support the development of pollution prevention and clean technology capabilities. For the purposes of this case, I investigated two identified areas of environmental institutional capital, the *relationship between operational activities and the natural environment* and the *relationship with stakeholders*.

The introduction of specific contextual factors to the consideration of environmental capability represented an important progression for research in this field. Although authors have argued that key elements of organisational context may be important (Moxen and Strachan, 1998), there has been little attempt to examine empirically the potential contributions in this area. The findings from this case illustrate clearly that the relative establishment of environmental institutional capital plays an important role in the capacity of the organisation as a whole to support environmental work.

Figure 9.4 summarises the key influences that emerged as playing a role with respect to the selected elements of environmental institutional capital in this study. In common with the empirical data explored so far, the Figure illustrates opposing forces at work.

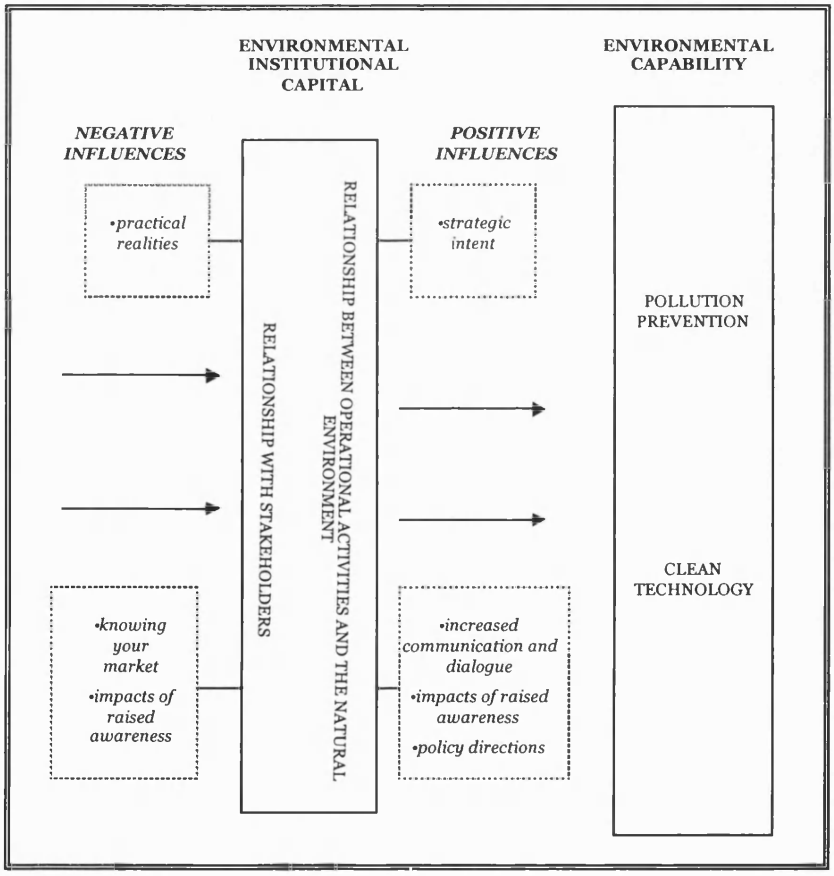

Figure 9.4: Summary Themes: Selected Elements of Environmental Institutional Capital

The way an organisation conceives the *relationship between its operational activities and the natural environment,* is key to the way it conducts its activities in the long term. In chapter three I suggested that managers perceptions of this relationship play an important role in determining the directions chosen for future developments (Halme, 1996). The findings from this study showed how ECC has been required to go some distance towards redefining these key relationships. This was occurring both in the way that ECC was choosing to direct its day-to-day activities (through more environmentally proficient lines driven by the company's environmental management programme) and at a more strategic level. Strategically, the company had been re-examining the way it managed the long-term environmental impacts of its operations. This had resulted in a new, emergent perspective that was aiming to incorporate more progressive environmental criteria into the way mining, closure and aftercare would be planned and managed (chapter eight, section 8.5.2).

Much of the evidence presented throughout the thesis (consolidated in chapter five) revealed a company reluctant to break with tradition and old allegiances. However, the study also provided empirical data which showed that managers were recognising the need for cultural change in an environmental context and were pushing for attitudinal change at all levels towards environmental concerns. This, as Oliver (1997) asserts, is necessary to strengthen institutional capital. Such an emerging position involved recognising the additional value of the company's natural capital (for example, in terms of amenity and conservation) beyond the mineral resource (Stead and Stead, 1996).

I would argue, therefore, that the findings were indicative of a company on the cusp, re-evaluating outdated practices and directing work with new, more forward-thinking policies. This represented a significant change for a company whose history (as explored in chapter five) was characterised by high levels of organisational inertia, and long periods during which operational activities endured largely unchanged. As a result, the challenge of instituting this breadth of cultural change (through new environmentally and socially responsive policy and practices) remained substantial.

While the role of dialogue and proactive interaction with stakeholders appears to be universally considered as a positive trait for companies in the 'greening' literature,

authors rarely reflect on the challenges that companies face when trying to become more receptive and engaged (Neale, 1997). In chapter three I proposed that by working towards a proactive relationship with stakeholders, companies could enhance their ability to develop the capacity associated with environmental institutional capital.

In this study the evidence showed attitudes towards key stakeholders (such as the local community and the regulator) changing across the company, to become more receptive. However, the findings also illustrated that a significant number of managers were still reluctant to accept the changing role of external stakeholders (chapter eight, section 8.6.3). This was even though at a senior level, the message from interviewees was that constituents should be recognised as having a more legitimate stake in the company's activities (Donaldson and Preston, 1995). These senior managers were displaying actions postulated by Oliver (1997), as being important in the development of institutional capital. Specifically, they were seeking to reappraise 'taken for granted practices' (for example with respect to community relations and donations) in order that relationships could be more effectively managed in the long term, for the mutual benefit of both parties.

Crucially though, the data pointed to a tendency for these changes to be occurring at an individual level, rather than being effectively co-ordinated across the organisation. As a result of this more haphazard progression towards proactivity, ECC were already experiencing problems. In particular, at the time of the study there was an acknowledgement that the company remained inadequately equipped to deal with the growth in communication (for example, in relation to environmental incidents) stimulated by a greater openness. These findings suggest, unlike the more prescriptive approaches advocated in some environmental management texts, that a more proactive stance does not necessarily bring immediate positive benefits. Rather, placing existing relationships on a new footing can bring additional, sometimes unforeseen, challenges for the company concerned.

9.3.5 Reflections on the Conceptual Framework

The preceding analysis has reflected on the empirical findings and used the components of the conceptual model (chapter three, section 3.7) to illustrate the main themes as they arose from the data. The model was developed both to assist in understanding how

the different components of the study interconnected, and to frame the analysis sections of the study. As such, the model has proved a useful tool to explore the concepts in this case. In this section I reflect on those elements of the framework which, on the basis of the study's findings, may need to be adapted. In particular, I consider two key amendments to the model and suggest how the framework may be developed for work in other organisational contexts.

The building blocks for the analysis of environmental capability (resource characteristics, moderators and selected elements of environmental institutional capital) were derived from a combination of empirical studies in the field to date and an analysis of the extant literature. The evidence presented in the analysis of each resource characteristic evaluated that in most instances the theoretical conception was a valuable one.

A key exception, outlined in the summary discussion above, was the characteristic of TQM. The analysis suggested that TQM as a construct, did not fit the original model as effectively as anticipated by the conceptual development in chapter three. This, I would argue, relates to the notion that TQM is best understood as a process, itself comprised of a series of parts (Ghobadian et al, 1998) (see chapter three, section 3.3.1). Crucially, in this study, elements of the TQM process, such as team and cross-functional working were considered separately as resource characteristics in their own right. This makes understanding the particular role of TQM, in the development of environmental capability, more difficult. Significantly, though, the absence of TQM practice in this case appeared to be exerting a negative influence in the areas of the environmental management programme examined. By failing to develop the more progressive working styles associated with TQM, the organisation was arguably limiting the capacity of employees to link quality and environmental objectives more dynamically (see chapter six, section 6.3.1). This suggests that TQM (or in this case, the absence of TQM) has the capacity to act in a moderating role, rather than as a resource characteristic, as conceived in the original model. Future research should therefore seek to reposition TQM as a moderator in the conceptual framework.

The analysis presented above and in chapter eight, showed the moderators explored in this study, to be exerting a significant (if largely negative) effect on the development of

environmental capability. Although not directly considered in the original conceptual development, it was interesting to observe throughout the study how *top management commitment* became increasingly important to the capacity of the company to develop more progressive environmental management approaches. The analysis of company stance towards the environment showed an explicit commitment, at senior level, to the development of the company ESH initiative. The empirical evidence pointed to this commitment being instrumental in the willingness of employees to become involved in environmental work. In addition, this expression of strategic intent was enhancing the capacity of managers to communicate with their expanding range of stakeholders (see chapter eight, section 8.5.2). In contrast, the environmental innovation projects lacked consistent backing at a senior level. The failure of the organisation to develop an environmental profile for its research efforts (see chapter seven, section 7.2.1) and the reported divisions between senior research and marketing personnel, contributed significantly to the commercial difficulties the company experienced.

These findings support the narrower branch of work on *environmental commitment* which contends that positive commitment can contribute to resource transformation, innovativeness and adaptability in organisations (Zeffane et al, 1993). Additionally, it has been argued that environmental commitment can act as a precursor to the development of visioning and strategy in organisations (Keogh and Polonsky, 1998). This suggests that environmental commitment may serve to moderate the development of appropriate capabilities, and should therefore be included in subsequent iterations of the conceptual model for the purposes of future research.

The empirical findings have indicated two key adaptations to the model for this case. If we examine how the model may be applied more broadly to other organisational contexts additional amendments may be necessary. It is important to be aware, at this juncture, of the criticism (discussed in chapter four, section 4.9.1) that case studies lack generalisability. When considering the relevance of the model developed in this study for future research it is helpful, as Vastag and Rondinelli (2001) assert, to make use of Campbell's (1986) concept of proximal similarity. Drawing on the work of Campbell (1986) the authors argue that researchers should,

> "... think about different generalisability contexts and develop theory about which contexts are more similar to the case study and which are less similar so ...

> generalisations are made across populations ..." (Vastag and Rondinelli, 2001), p. 1260).

The development of potential moderators in this case related explicitly to the key issues associated with environmental project innovations and the challenges of environmental management in a natural resource extraction context. These moderators may therefore be limited in their application, for example, to service industry or new technology firms. As such, future developments of the model may benefit from further conceptual development to determine moderators more appropriate to alternative organisational settings. Work to date suggests that the additional issues revealed in this study (TQM and environmental commitment) may be usefully supplemented by other factors that include, the availability of:

- *finance*;
- *technology*;
- *physical assets*;
- *human capital* (Christman, 2000; Hitt et al, 2001).

Similarly, the elements of environmental institutional capital investigated also relate closely to the industry context in this study. Future development of the model, beyond extractive companies, may wish to embrace other potential elements of institutional capital such as:

- *inter-firm knowledge sharing*;
- the development of *stakeholder networks* and;
- resource characteristic enhancing *training programmes* (Oliver, 1997; Clarke and Roome, 1999).

The original conceptual model presented the different components of the study in a linear fashion, suggesting a stepwise progression for the organisation through a series of developmental stages towards environmental capability. However, the evidence presented throughout this thesis has indicated that in reality these components vary both in strength and form. More realistic then, is to consider the elements of the study as continually interacting in a dynamic and cyclical manner. These changing relationships are illustrated in an amended model (Figure 9.5) which takes into account the reflections on the conceptual work discussed in this section.

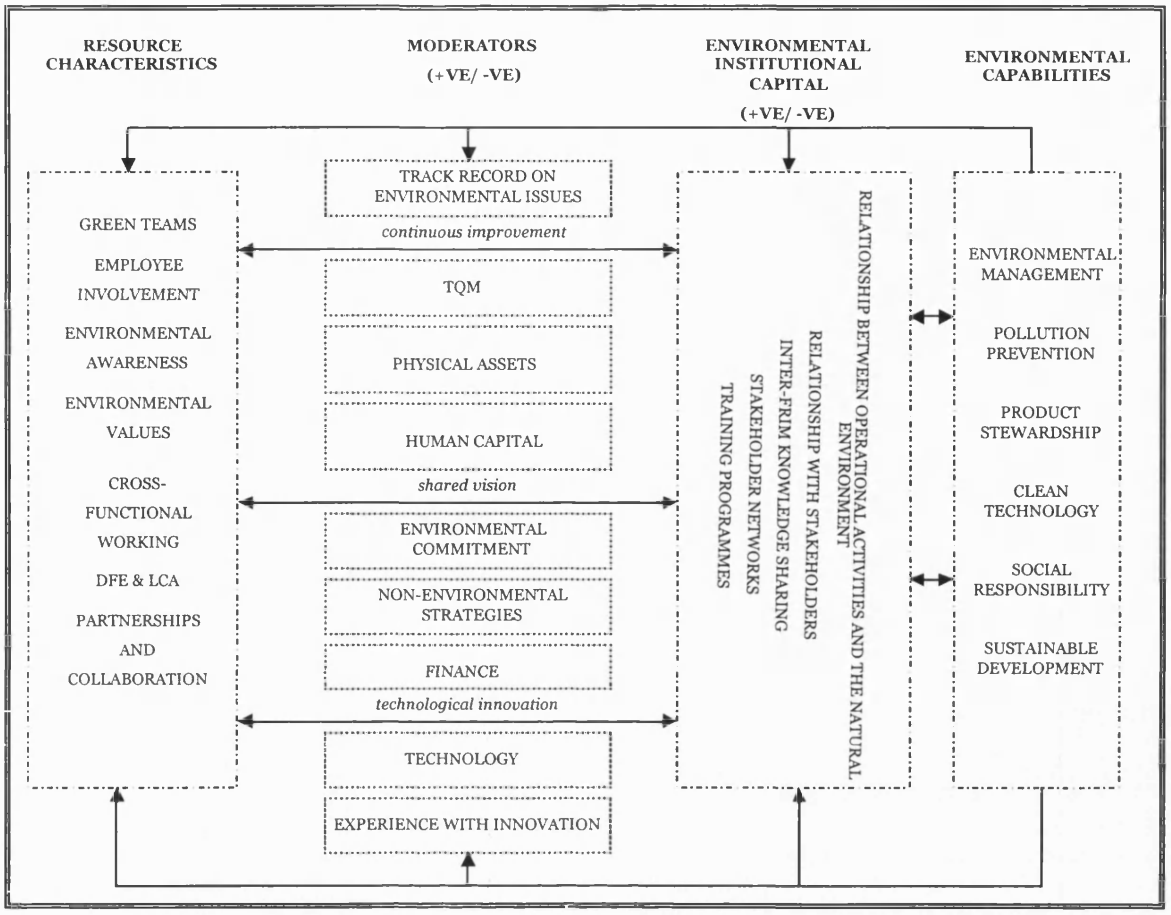

Figure 9.5: Revised Conceptual Framework.

9.4 Chapter Summary

This chapter has reflected on the central theme of the study, through an analysis of the key findings from chapters (six, seven and eight). In doing so I have considered whether the case company was able to demonstrate the identified resource characteristics, and discussed as a whole the relative influences of the moderators and the selected elements of environmental institutional capital investigated by the study.

I have argued that the evidence presented with respect to the 'pollution prevention' propositions supports them as being both conceptually valid and empirically useful. The key exception related to the development of TQM practice. Environmental texts consistently suggest that TQM is complementary to capability development, however, the findings from this case suggest that this proposition may need further investigation.

While the findings in this case revealed a limited demonstration of the characteristics considered by the 'clean technology' propositions, I would argue that the conceptual value of the propositions holds. Key in this study was the observation that while these characteristic building blocks were desirable, they were not necessarily essential for this innovation path. Even with the important caveat of commercial success, these findings point to the need for an expansion of the propositions to empirically investigate additional characteristics that enable firms to take alternative innovation routes.

The evidence presented in this thesis pointed categorically to the important role that moderators play in the development of key resources. This suggests both conceptual value and opportunities to expand on these ideas through further empirical testing of additional, potential moderators. The significance and merit of investigating organisational context more thoroughly, when considering the development of environmental capability is a key theme that runs throughout the structure and presentation of this study. The evidence showed this conception to be valuable in terms of understanding the institutional foundations of capability development. Again the necessarily limited propositions considered in this case, would benefit from extension and further empirical investigation which explores additional influences on the development process.

Reflections on the conceptual framework used in this thesis suggest that opportunities exist to rework some of the concepts employed. I suggest that the TQM characteristic is more effectively conceived as a moderator and, that additional moderators may be appropriate both to this case, and in the future application of the framework to new organisational contexts. Ongoing work may also seek to reflect the more dynamic relationships between the model components that emerged during the course of the study.

In summary the evidence pointed to a significantly more complex picture of capability development than is reflected in the literature. The addition of this detail to the emerging understanding of environmental capability in firms forms an important part of this thesis' contributions. The extension to the existing body of knowledge in this field is considered further in the next chapter.

Chapter Ten: Conclusions

10.1 Introduction

This thesis was framed by the newly emerging field of environmental management strategy. In chapter two I demonstrated how new contributions from strategic perspectives and organisation theory have strengthened the quality of work examining the interactions between organisations and the natural environment. This study has drawn on a range of these perspectives in order to develop and explain the ideas and concepts presented. The plurality of this approach is reflected in comments made by other researchers in the field (Bansal, 1995; Bowen, 2000b), that even when restricted to an organisational context, environmental issues do not fall definitively within the bounds of any single, theoretical field. However, the practicalities of research call for delimitations. This study has therefore built most significantly on work in the areas of resource-based strategy and institutional theory in order to provide an improved understanding of the development of environmental capability.

This concluding chapter considers the value of the approach taken by discussing and reflecting on the contributions and limitations of the study. The chapter is organised into three main sections. In the first section I consider the contributions of this work to the literature, identified in chapters two and three, as requiring extension. The second section reflects on the limitations of this work from both a theoretical and a methodological standpoint. In the third section, I look forward on the basis of this discussion and the previous analyses, to the opportunities for future research in this field. The chapter concludes with a brief summary outlining the key points made in the preceding discussion.

10.2 Contributions

In chapter two, I evaluated the extant literature and suggested that opportunities existed to undertake empirical work that examined the development of environmental capability in the firm in more detail. The subsequent development of the research propositions, and the application of an appropriate methodology, reflected the openings highlighted by this analysis. In this section I outline the key contributions facilitated by the conceptual developments and the empirical findings of this study.

10.2.1 Disaggregating Environmental Capability

This thesis represented a first attempt at adapting and using Hart's (1995) natural-resource-based-view of the firm (see section 2.11.1, chapter two) in an explicitly more detailed way. Following the introduction by Hart (1995) of a conceptual framework for environmental capability and its subsequent development in 1997 to include the concept of clean technology, a number of authors have to sought to draw on and expand these ideas (Hart and Ahuja, 1995; Sharma and Vrendenberg, 1998; Hastings, 1999). However, most studies in this area test these concepts at their most aggregated level, focusing on the 'end point' of these resource-based inspired ideas by seeking to determine whether there is a relationship between the hypothesised environmental capabilities and competitive advantage.

In chapter two I argued that no attempt had been made in the published literature to 'unpack' the composition of environmental capability such that we might understand better the nature and strength of forces that may be shaping, what I termed, the underlying 'resource characteristics'. This thesis has filled a gap in this area by demonstrating the value of exploring resource characteristics in more detail. I have shown that the development of each characteristic may be subject to a range of influences that serve to either enhance or detract from their establishment in the organisation. Significantly, I have also shown that weaknesses in particular characteristics such as TQM, DFE and LCA (hypothesised as being a valuable part of capability development) do not necessarily have an adverse effect on the capacity of the company to demonstrate the environmental capabilities of pollution prevention and clean technology. (Although as I note below, this study did not then go on to test whether these capabilities were themselves competitively valuable for this firm).

These findings are important for two reasons. First, they provide empirical support for Collis and Montgomery's (1995) argument that the disaggregation of resources avoids the 'vacuousness' of generic statements about capability. The specificity of the 'resource characteristic' approach provides powerful insights that are more likely to derive actionable implications for the firm. Second, the data suggests that there may be a need to re-evaluate some of the key resource characteristics (such as TQM) that most authors have accepted without challenge as being relevant to the development of environmental capability in the firm.

10.2.2 The Influence of Moderators

In chapter three (section 3.5) I argued that in spite of the availability of existing theoretical pointers (contingency theory), few authors working from an environmental perspective have attempted to explore the role of moderating variables in the development of environmental capability. This work (in this thesis) provides a first attempt to explicitly address how three identified factors internal to the firm, may ultimately influence the development of environmentally-valuable capability. Importantly for our understanding of the capability development process, the analysis identified that the moderating factors examined in this case, do in fact, have a profound and often negative influence on the underlying resources that authors have considered valuable (Hart, 1995; Bowen et al, 2001). Interestingly, several of the influencing themes which emerged from the study (loss of personnel and worker morale, see Figure 9.3, chapter nine) related to the existence and application of human capital. In a recent study, Hitt et al (2001) identify human capital as exerting a moderating effect on the strategy-performance relationship of the firm, and the authors also point to the need for further studies to examine other resources in the context of this resource-strategy contingency fit. The findings from this thesis provide support for this proposition as well as opportunities to explore these ideas further in an environmental context.

This study also provided the empirical evidence for previous suppositions made by researchers (Sharma and Vrendenberg, 1998), that positive changes to environmentally valuable characteristics and resources (for example, 'green teams' and continuous improvement) may be more accurately attributed to the influences of other contemporaneous organisational initiatives. As indicated in the previous chapter (section 9.3.3) these findings resonate strongly with recent work by Christmann (2000), who suggests that existing 'complementary assets' (for example in process innovation) are often necessary for firms to develop cost advantage from environmental practices. In other words, 'good' or 'best' environmental management practices alone are not sufficient for environmental (and potentially competitive) improvements. The identified influence of moderators in this case, provides an important contribution to the broadening of resource-based perspectives in an environmental context.

10.2.3 Incorporating Organisational Context

This thesis provided an important empirical contribution by illustrating the value of introducing organisational context into the environmental capability development debate. The critical analysis in chapter two (sections 2.10.3 and 2.18.1) pointed to the need for resource-based perspectives to also embrace the social context framing the evolution of resource characteristics and key resources. Similarly, authors working in an environmental context had identified organisational context as a potentially important, but neglected, area of research (Moxen and Strachan, 1998; Rothenberg et al, 1998).

Oliver (1997) provided the conceptual foundations for this element of the study, by arguing that researchers could derive insights from considering the complementarity of resource-based and institutional theories. This thesis operationalised Oliver's (1997) ideas at the firm level, and drew on the extant environmental literature (Halme, 1996; Hastings, 1999) to pursue two identified factors. In doing so I introduced the concept of 'environmental' institutional capital which was interpreted using Oliver's (1997) definition as being a contextual environment that enhanced the optimal use of environmentally valuable resource capital.

Specifically, it was shown that the development of this environmental institutional capital through organisational structures that supported knowledge sharing (*stakeholder relationships*) and cultures that challenged out-dated management practice (*relationship between operational activities and the natural environment)* was an important step towards a pollution prevention environmental capability. As such the study provided useful empirical evidence to justify a more detailed exploration of these theoretical complementarities through an expansion of the 'environmental' institutional capital concept. This work also contributed incrementally to the emerging debate in the environment-business literature, which suggests that it is multiple theories using a common framework, that will provide the most useful analytical opportunities and answers in the 'greening' arena (Prakash, 2000).

10.2.4 Identifying Negative Resources

The discussion in chapter two (section 2.10.3) highlighted the tendency of strategy researchers to focus primarily on the competitively-valuable assets of the firm, and in particular, on those resources that contribute most towards the development of dynamic capabilities (Montgomery, 1995). An additional contribution of the thesis was

to explicitly consider and draw attention to those factors that may serve to undermine or impact negatively on firm performance. In this case the implicit value afforded to organisational context, illustrated how, for example, firm tradition could detract from the development of essential, environmentally valuable resource characteristics. The analysis presented in chapter five explained how, at ECC, the firm's reputation could be viewed as encapsulating the rare and imperfectly inimitable advantages that result from a unique history (Barney, 1991). This research indicated clearly that, when considered in the light of new strategic requirements (for example, a more dynamic supplier-customer interface) this previously valuable resource, could be seen to be exerting negative influences. These findings relate to Leonard-Barton's (1992) concept of 'core rigidities' and suggest that research needs to take greater account of how the merit of particular resource endowments may alter in the light of changing strategic priorities.

By paying attention to and drawing out the role of negative resources, this study has bucked the trend of resource-based research and environmental management research in particular, which has tended to focus exclusively on 'best practice' examples and delivering prescriptive methodologies for business. As such, this study contributes a more pragmatic perspective, which recognises that firms are required to operate in the context of existing resources and assets that may not necessarily complement the new demands brought by environmental objectives.

10.2.5 Sub-organisational Analysis

In this I study chose specifically to explore the development of environmental capability through embedded units using a case study strategy. By doing so I contributed a more detailed picture that explicitly took account of the nuances and subtleties of the organisation concerned. This approach filled an identified gap in the extant literature on environmental capability (chapter two, section 2.18.2) where analysis showed that studies had tended to focus on capability at the aggregate level, using surveys and large sample sizes. By reducing the level of analysis (but maintaining an organisational level overview) this study was able to provide a deeper and richer perspective than survey-based approaches alone. This approach also answered calls from researchers that inquiries should consider both character of resources (Foss, 1997), and the fact that resources may exist in hierarchies (Conner, 1991), and therefore need to be considered at different levels (see chapter two, sections 2.3.1 and 2.4).

Significantly, the value of this sub-organisational approach is supported though recent work by Lankoski (2000), in her thesis which examines the relationship between environmental and economic performance. The author's findings (which combine statistical and case study data) suggest that to understand the variations between firms, it is necessary to focus on factors at a sufficiently disaggregated level. She argues that by abstracting to firm level and above to industry context, the variation between firms becomes more difficult to explain and, as a result, much of the explanatory power of analysis may be lost.

10.3 Limitations

In the following sections I discuss limitations to the findings and contributions outlined in the previous chapter (nine) and the preceding sections. The limitations to the study arise from both theoretical and methodological choices made prior to and during the study. In this sense, some limitations reflect pragmatic choices that necessarily defined the boundaries of the study and restricted its scope in order to make it a manageable piece of work. Constraints on the nature of the research and the broader applicability of the study are therefore outlined below.

10.3.1 Theoretical Choices

This study employed a combination of resource-based and institutional theory to explore the development of environmental capability at ECC. I also drew inspiration and supporting evidence from work on innovation, broader environmental management literature as well as different elements of organisation theory suggested by Gladwin (1993).

As noted in chapter two (section 2.13.5) there are a range of organisation theory perspectives from which I might have drawn theoretical grounding. By choosing (for reasons discussed in chapter two, section 2.16) to draw primarily on resource-based work I have implicitly taken on board some of the assumptions associated with this approach. For example, earlier discussions pointed to the rather static and bounded conceptions of the firm associated with resource-based views (RBV). To combat these limitations I attempted, as Scarborough (1998) suggests, to incorporate an appreciation of the social dimension that may influence resource-related decisions and firm actions. I

also employed institutional perspectives that implicitly embrace social, contextual criteria.

Nevertheless, it is important to be aware that any conceptual framework will direct research along a path particular to its theoretical grounding and that as such, the applicability and generalisability of the findings associated with the framework are restricted to the relevant theoretical context. Employing alternative theories may well have resulted in a different interpretation of the findings from this case.

10.3.2 Internal Focus on Selected Empirical Indicators

Resource-based perspectives have been critiqued for focusing at the level of the firm and neglecting external and institutional environments (chapter two, section 2.11). This study is also similarly limited in that it focuses primarily on the firm. The analysis does, however, attempt to overcome this criticism by also focusing at a sub-organisational level and by breaking down the notion of the firm as a unitary actor through highlighted internal influences (as characterised by the analysis 'themes'). This exploration and analysis inside the 'black box' has contributed new insights to the development of environmental capability in the firm.

What the research does not seek to do is 'unpack' the perspectives of the external actors considered in this case. For each embedded unit the study addressed issues associated with constituents who included the local community, regulatory bodies and key customers in the paper industry. The analysis suggested that in each case, these actors were capable of influencing the way resource characteristics were developing in the case company. However, the evidence presented in this case relies primarily on company perceptions of these relationships, and as such should be considered a limitation of the data. Future research may therefore seek to examine these relationships more closely, in order to improve our understanding of exactly how external constituents may influence capability development.

The research also focused on selected resource characteristics that I conceptualised as being sub-elements of environmental capability. These selections were based on a detailed analysis of the extant literature and were also delimited by the pragmatics of the study. However, they should not be considered exhaustive and as such it is likely that there may be additional characteristics that could be investigated in an

environmental capability context. The role of team working in particular, and its synergies with TQM and cross-functional working deserves more detailed exploration, especially in firms subject to significant ongoing organisational change. Additionally, while the study focused on three identified moderators, both the literature (chapter three, section 3.5) and the subsequent analysis in this thesis pointed to other factors such as firm structure and internal organisational politics as being potentially influential.

10.3.3 Exclusion of Financial Measures

In developing the rationale for this study I chose to draw on resource-based perspectives in order to augment our understanding of environmental capability. If pursued to its logical conclusion, the essence of resource-based thinking is concerned with the mechanisms for attaining and sustaining competitive advantage, or from the natural resource based perspective, *environmentally* sustainable competitive advantage (Hart, 1995).

However, in this thesis, I deliberately focused on the underlying detail of how capabilities develop, rather than how they perform for the firm on aggregate. As such, I did not seek to investigate either the financial costs of resource development or the potential cost or competitive advantages brought by their aggregate application. This may be seen as a limitation of the findings, but in research terms it also reflects the difficulties involved in obtaining accurate data in this area. Few firms (including the case company) have yet to develop accounting measures that allow environmental expenditure and the gains brought by environmentally beneficial improvements, to be accurately tracked (Gray, 1992).

The findings do, however, allude in places to areas where an accumulation of valuable resource characteristics and the development of environmental institutional capital, may have brought long term competitive and environmental advantages (for example in securing planning permissions for future mineral extraction, which are subject to more stringent environmental criteria). Further, the improvements brought by reviewing organisational practices through the CPI initiative had brought demonstrated cost savings.

10.3.4 Methodology and Methods

This study, for reasons outlined in chapter four (section, 4.3) employed a case study strategy to gather data. As Yin (1994, p. 31) notes, case studies are not appropriate for the level of generalisation associated with large sample sizes and are best suited to what he terms 'level two' inferences that relate the study findings to theory or rival theory. This level of generalisability could arguably, limit the application of the study findings. There have also been some recent criticisms of case-based work in the emerging field of environmental management strategy which suggest that researchers in this area need to expand their methodological approaches beyond case work (Starik and Marcus, 2000).

I would argue that in this study, additional merit is drawn from the detail obtained by applying Yin's (1994) embedded single case design. This study also contributes to a broader picture being developed by other recent case-based research (Perales, 2000) that when considered cumulatively, is aiming to build a deeper understanding of environmental and social change in extractive companies. Additionally, the pragmatic perspective adopted here reflects a need (at the point where academic literature is applied for practitioner use) for findings and examples that are useful for managers. Although industry level work using large-scale survey data clearly has its place in furthering the research agenda, it is overwhelmingly material derived from case-based work which provides managers with learning opportunities.

Any data gathering method carries with it potential issues of bias and intrinsic limitations which were discussed in some detail in chapter four (section 4.9). In this study, interview choices were deliberately selective, focusing largely at managerial level in order to obtain data at a strategic level. Discussions relating to environmental management, or indeed any other potentially sensitive areas, are always subject to the possibility that the interviewee may seek the 'correct' or most politically acceptable answer. In developing the interview protocol and in the conduct of the interviews themselves, I was aware of limiting the opportunities for interviewees to seek 'correct' answers. In addition I employed triangulation techniques. There is always the chance though that evidence gathered through interviews may be tempered by data that reflects what the interviewees thought they 'ought' to say, rather than an expression of their actual opinion on the issue. Interpretations of the data need, therefore, to be cognisant of this potential bias.

To obtain a broader perspective on the development of key resource characteristics, the study also employed a survey questionnaire. In using a self-report instrument there exists a danger of 'strategic responding' which, again, reflects the tendency of respondents to seek 'correct' answers. In the analysis of the organisational value statements (chapter six, section 6.7.4) I noted that there appeared to be little variation between either the hierarchies or the functional groups across these statements. As indicated in the analysis, this differed from expectations and may reflect either questions bias and/ or a level of 'strategic responding' by company employees. These observations suggest that any assertions made on the basis of these findings need to reflect this uncertainty.

10.4 Future Research

Previous discussion in chapter nine pointed to a number of possible future research directions based on the findings from this study. Some opportunities exist to extend or repeat certain aspects of the empirical work undertaken, others relate more broadly to conceptual issues in the literature. The following sections consider future research avenues in turn.

10.4.1 Expand Empirical Investigation of Resource Characteristics

This study represented a first attempt at 'unpacking' the resources that have been conceptualised as underlying environmental capability. As such there remains significant work to be done in terms of:

- exploring the extent to which these characteristics exist in other firms both in the extractive industry context and in others;
- investigating further those characteristics with synergies (for example team working) as well as other characteristics not considered in this study;
- understanding how the range of influences (characterised by 'themes' in this study) operate in other firms;
- synthesising this data so that we may discern patterns;
- making suggestions as to which characteristics contribute most towards environmentally (and competitively) valuable capability;

- indicating where particular organisational practices or structures may enhance or inhibit the development of characteristics identified as being significant.

10.4.2 Explore Additional Moderators

This thesis considered the influences of three moderating factors in relation to the development of environmentally-valuable resource characteristics. Of particular note during the study was the emergence of 'internal organisational politics' as playing a key role in influencing decisions and deciding both the path and speed at which projects could develop. The ability of the political climate to create either a positive or negative environment for environmental work was implied by a number of interviewees. For example, it was observed that the environmental projects received support and funding through an unconventional decision route that related largely to the personal relationships of the actors involved, rather than any formal, recognised strategic decision path (chapter seven, section 7.2.2).

Other researchers in the field (Prakash, 2000) have also argued that the role of politics in environmental decision-making and management has been under-investigated. Prakash (2000) notes, as I have observed with respect to resource-based perspective, that economic theories tend to treat firms as unitary actors and as such there is an:

> "... inadequate understanding of the internal politics that lead firms to adopt different environmental practices." (Prakash, 2000, p.2)

Further, as Lankoski (2000, p. 152) also asserts:

> "... it is evident that environmental questions are not an independent island among business issues ... rather they are tightly linked to various areas in business decision making."

Future research may therefore seek to explore more carefully the 'how' and 'why' of managerial decision-making as it relates to the influence of internal organisational politics, from a capabilities perspective.

Reflections on the value of the conceptual model also highlighted the possible role that environmental commitment may play in moderating the development of environmental capability. Senior commitment to environmental initiatives, was not considered

explicitly in this study, but the evidence which emerged from the case supports previous assertions (Keogh and Polonsky, 1998) that commitment is an important dimension in understanding the development of environmental capability. Future research may therefore seek to investigate the role of top management commitment in more detail.

10. 4.3 Investigate Path Dependency

The concept of path dependency is a key part of Hart's (1995) conceptual framework, and features throughout much of the resource-based literature (see chapter two, section 2.6). The notion that firms need to build cumulatively on experiences and develop competencies over time is both an attractive and intuitive concept that is frequently employed to explain the successes of long-lived companies (DeGeus, 1997). Although path dependency has both positive and negative connotations (Leonard Barton, 1992) it is usually the positive aspects that receive the most attention in the capabilities literature.

In this study, the negative aspects of path dependency were strongly demonstrated through the difficulties experienced by the firm with its environmental innovations (particularly at the commercialisation phase). These problems, it is argued, resulted from a reliance on existing, 'product focused' experience. Interestingly, however, the evidence also pointed to this organisation being able to innovate successfully (along the lines afforded by the conceptual criteria) without adequate evidence of the appropriate foundations for environmental work. This suggests that there may be a need to investigate further, particularly in the context of environmental innovation, the extent to which this type of work is in fact path dependent or, whether firms are able to 'leapfrog' on the basis of existing skills and knowledge.

10.4.4 Combining Resource-Based and Institutional Views

This thesis drew on the conceptual work of Oliver (1997) in order to introduce and develop the concept of *environmental institutional capital.* In doing so this work has illustrated the empirical value of theory complementarity in an environmental context. This relates to the broader debate in the literature which is currently discussing the use of multiple theories to help explain 'greening' phenomena (Starik and Marcus, 2000). This work also supports the findings of several recent theses in this field (Bowen, 2000b; Perales, 2000) which have also contributed significantly to this debate, by illustrating the complementarity of resource-dependency and institutional theories.

The first steps taken in this thesis of employing the firm level element of Oliver's (1997) framework suggest that significant value may be gained from exploring the opportunities of this combined approach further. The concept of environmental institutional capital suggests a range of possible research opportunities related to a more thorough investigation of the social context surrounding environmentally valuable capabilities.

10.5 Chapter Summary and Concluding Remarks

This chapter has drawn together and emphasised the key contributions made by this study. I have argued that a combination of resource-based theory and institutional perspectives provided a conceptually useful approach to the examination of environmental capability. The findings have served to expand both the capability debate and the growing acceptance of studies that draw on multiple theoretical foundations to explain the evolving relationships between organisations and the natural environment. The discussion has also highlighted a number of limitations that reflect both theoretical assumptions and methodological choices made as part of the research process. In outlining the limitations I have in particular drawn attention to the applicability of the findings to other researchers and practitioners, reflecting Yin's (1994) analysis of case studies which point to their role in analytic generalisation.

By contributing to the growing and strengthening research field that is looking to ground environmental research in more rigorous theoretical foundations, I have opened up a number of avenues for further investigation. Several involve pursuing novel findings, such as the role of moderators, in more detail. Other opportunities suggest the need to examine existing concepts and ideas in a new light.

The 'greening' of organisations is simultaneously one of the most perplexing and challenging issues of our time as it embraces academic interest across disciplines in a way that few other research fields can achieve. A significant volume of environmental management writing has focused on why companies go 'green' and has offered prescriptive methodologies and strategies for greening. There has however been a concerted move towards a more realistic appreciation of the greening phenomena which takes into account the socially constructed nature of environmental issues (Fineman,

2000). This thesis has provided an important contribution to these emerging areas of work by looking inside the firm in detail in order to understand both how firms improve their environmental capability, and crucially, how contemporaneous organisational phenomena and strategies may influence any changes that are taking place.

Appendix i: Interview Protocols

Interview Protocol
Environmental Management Programme

Capabilities, Resources, Resource Characteristics	
• What skills and knowledge has your organisation required in order to address environmental issues?	[process specific, legislative, systems]
• To what extent did your organisation already possess the necessary capability?	[in place, adapted existing procedures, absent]
• How has your organisation gone about acquiring additional capabilities	[internal development, teams, consultancy, collaboration]
• How might capability be most effectively developed in the future?	[requirements, measurement, resources]
• What are the main environmental issues being discussed in the organisation?	[regulatory, customer, internal compliance etc]
• What do you foresee as being the key environmental issues of the future?	[operational, e.g., strategic, e.g.]
• From where inside the organisation does the impetus environmental change stem?	[senior, leaders, departments, co-ordinated, for ad-hoc]
• To what extent would you say that environmental issues are integrated into company policies and practices?	[barriers (physical/ perceived), opportunities]

Moderators

• In what ways have other internal organisational initiatives affected environmental work?	[positive/ negative, examples]
• In what ways have recent company reorganisations affected environmental work?	[progressed, hindered, examples]
• How does the organisation's environmental work compare with competitor organisations in the industry?	[better/ less competent, examples]
• What lessons have been learned from past experience with environmental initiatives?	[improved practices, new processes?]

Environmental Institutional Capital

• Why is the company engaged in environmental activity to the extent that it is?	[drivers, context, tradition]
• To what extent will environmental management initiatives be a part of future organisational development?	[increasing/ diminishing, strategic/operational]
• Who would you identify as key stakeholders?	[local, remote]
• In what ways do identified stakeholders impact the business?	[operational/ strategic, long term/ short term]
• How would you characterise your relationship with key stakeholders?	[proactive, reactive, defensive, accommodating]

Interview Protocol
Environmental Product and Process Innovation Activities

Capabilities, Resources, Resource Characteristics

• What are the key environmental issues currently being discussed in R&D?	[operational, product oriented/ specific etc.]
• What do you foresee as being the key environmental issues for R&D in the future?	[process innovations, meeting customer requirements, reflection of paper industry concerns?]
• From where inside the organisation has/ does the impetus for environmental product innovation stem?	[top down, bottom up]
• To what extent are environmental concerns integrated into R&D policy and practice?	[strategic vision, ad-hoc projects]
• To what extent has environmentally oriented work put new demands on the way you work in R&D	[new teams, groupings, structures, communications, internal and external]
• How was the process from conception through development managed?	[integrated, compartmentalised, R&D/ marketing interface]
• How did the organisation go about identifying possible process niches?	[internal, LCA based criteria, external, product/ customer driven, drivers]
• To what extent did research make use of design for environment criteria?	[DfE, LCA, present/ absent]
• Have any new relationships emerged through the pursuit of environmental goals? (Any spin-offs?)	[customer, competitors, internally?] [new business, products, organisational learning?]

Moderators

• In what ways have other internal organisational initiatives affected environmental innovation work?	[positive/ negative, examples]
• In what ways have recent company reorganisations affected environmental work?	[impact of McKinsey, business unit structure]
• How does the organisation's environmental innovation work compare with competitor organisations in the industry?	[ahead, comparable, behind – reasons]
• What lessons have been learned from past experience with environmental innovation?	[improved practices, new processes, streamlined approaches?]
• How does the process of environmental R&D compare with past and present R&D projects?	[new knowledge, skills, resources]

Environmental Institutional Capital

• Why is the company engaged in environmental R&D activity to extent that it is?	[drivers, context, tradition, competitive the advantages]
• To what extent will environmental innovation initiatives be a part of future organisational development?	[increasing/ diminishing, strategic/operational]
• Who would you identify as key stakeholders?	[local, remote]
• In what ways do identified stakeholders impact the business?	[operational/ strategic, long term/ short term]
• How would you characterise your relationship with key stakeholders?	[proactive, reactive, defensive, accommodating]

Supplementary Interview Protocol
Environmental Product and Process Innovation Activities

Capabilities, Resources, Resource Characteristics

• What was the impetus for providing an environmental service arm to the organisation's US portfolio?	[customer demand, commercial opportunity]
• How have you gone about developing your environmental portfolio?	[internally, cross-functionally, external, partnerships]
• How is the relationship between US and UK counterparts managed?	[informal, formal, strategic level]
• How would you describe you relationship with customers the CheMin strategy?	[close- long term, changeable competitive under environment]
• How would you describe the achievements of this approach to date?	[costs, expertise, relationships etc.]

Appendix ii. Project Questionnaire

UNIVERSITY OF BATH
SCHOOL OF MANAGEMENT

ECC International

QUESTIONNAIRE

ENVIRONMENTAL ISSUES AT ENGLISH CHINA CLAYS INTERNATIONAL

This questionnaire is part of a three year research project on **environmental management** and **strategy** being undertaken at the International Centre for the Environment, University of Bath. The project is funded by **ECCI's Research and Development** department and the Economic and Social Research Council.

This questionnaire is designed to investigate environmental awareness at ECCI, and is interested in the opinions of all company employees. The results will be used to inform company **environmental practice** and **strategy** which is currently under development through the **Environment, Safety and Health (ESH)** initiative. This work is supported by **Dr David Skuse** in Research and Development and **Philip Larson** in Mineral Resources. **Instructions** to complete the questionnaire are given next to each question. All your answers are **confidential** and individual responses will not be identifiable in any reports. This questionnaire takes around 15 minutes to complete.

If you have a query about this questionnaire, or would like to know more about this research project, please contact :

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THANK YOU FOR YOUR TIME AND EFFORT

Section One: Environmental Issues

Please note that these questions refer to ECCI UK.

Question 1.

a) <u>In your view,</u> on which of the following areas do ECCI's mining activities, (extraction, processing, refining and drying) impact? (Please tick all that apply).

___ Air
___ Water
___ Soil
___ Landscape
___ Habitat (plants and animals)
___ _____other (please specify)
___ Climate
___ Human beings
___ Cultural heritage (e.g. historic buildings)
___ Transport
___ Housing

b) Please rank in your opinion, the <u>TOP 5</u> areas on which ECCI's mining activities impact, (where 1 = the highest impact and 5 = the lowest impact, **<u>choose five only</u>**).

___ Air
___ Water
___ Soil
___ Landscape
___ Habitat (plants and animals)
___ Climate
___ Human beings
___ Cultural heritage (e.g. historic buildings)
___ Transport
___ Housing
___ _____ other (please specify)

Question 2.

Which of the following groups do you think is most interested in the environmental impacts of ECCI's mining activities? (Please <u>rank</u> the groups where 1 = most interested and 5 = least interested).

___ Shareholders
___ Customers
___ Regulators (e.g. Mineral Planning Authority, Environment Agency)
___ Local community
___ Interest groups (e.g. Cornwall Wildlife Trust, Friends of the Earth)

Question 3.

In your view, how important are ECCI's environmental impacts <u>as a whole,</u> (mining and product distribution) at the following geographical levels? (Please circle the appropriate number).

	Not Important	Less Important	Neutral	Important	Very Important
Local (in and around St. Austell)	1	2	3	4	5
Regional (Cornwall and Devon)	1	2	3	4	5
National (UK)	1	2	3	4	5
Europe	1	2	3	4	
International	1	2	3	4	5

Section Two: Environmental Issues - Your Views

Question 4.
Please indicate how important the following factors are to <u>you</u>. (Please circle the appropriate number).

How important is the following to <u>YOU?</u>	Not Important	Less Important	Neutral	Important	Very Important
Tip Restoration	1	2	3	4	5
Pipeline Burst Containment	1	2	3	4	5
Employee Safety	1	2	3	4	5
Community Relations	1	2	3	4	5

Question 5.
Please rank the following factors in the order that, <u>in your opinion</u>, best reflects the way that ECCI <u>should</u> do business, (where 1 = the most important and 5 = the least important).

___ **Creativity** (willingness to put good ideas into practice)

___ **Environment** (the natural environment)

___ **Product Quality**

___ **People** (good relations with employees, suppliers and customers)

___ **Profit** (increasing)

Section Three: Environmental Issues - Your Company's Views

Question 6.
Please indicate how important you think the following factors are <u>to ECCI</u> when considering the company's current operational practices. (Please circle the appropriate number).

How important is the following to <u>ECCI?</u>	Not Important	Less Important	Neutral	Important	Very Important
Tip Restoration	1	2	3	4	5
Pipeline Burst Containment	1	2	3	4	5
Employee Safety	1	2	3	4	5
Community Relations	1	2	3	4	5

Question 7.
Please rank the following factors in the order that you think ECCI's <u>Senior Management</u> would rank their importance, (where 1 = the most important and 5 = the least important).

___ **Creativity** (willingness to put good ideas into practice)

___ **Environment** (the natural environment)

___ **Product Quality**

___ **People** (good relations with employees, suppliers and customers)

___ **Profit** (increasing)

Section Four: Environmental Practice and Strategy

Question 8.
Please respond to the following statements. (Please circle the appropriate number).

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
a) **Environmental management is a necessary part of ECCI's operations.**	1	2	3	4	5
b) **At ECCI, employees help in the design of environmental training programmes.**	1	2	3	4	5
c) **ECCI works in partnership with both private and public sector organisations to find solutions to environmental problems.**	1	2	3	4	5
d) **ECCI considers the environment when designing new projects and creating new products.**	1	2	3	4	5
e) **ECCI has clear, understandable environmental objectives.**	1	2	3	4	5
f) **ECCI involves employees at all levels in the development of environmental projects.**	1	2	3	4	5
g) **At ECCI, departments share environmental best practice.**	1	2	3	4	5

Question 8. continued

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
h)					
Environmental protection is an integral part of ECCI's quality system.	1	2	3	4	5
i)					
Environmental Management is a business concern at ECCI.	1	2	3	4	5

Question 9.
If ECCI was to change its response to environmental issues should the company:-

(choose one only)

___ be more environmentally responsive?
___ be less environmentally responsive?
___ keep the same environmental response?

Section Five: About You

Question 10.
Please indicate the department in which you are employed. (Please tick as appropriate).

Business Units:-
Ceramics
___ sales
___ marketing
___ technology
European Paper Group
___ sales
___ marketing
___ technology
Performance Minerals
___ sales
___ marketing
___ technology

Product Supply:-
___ mineral resources
___ wet operations
___ dry operations
___ engineering
___ technology
___ logistics
___ purchasing

Shared Services:-
___ human resources
___ information technology
___ finance

___ **Central Research Laboratory**
___ **Euroboard**

Question 11.
Please indicate your position.

a) Operations, (Please tick as appropriate).

___ Mines Manager
___ Senior Captain
___ Shift Captain
___ Day Captain
___ Chargehand

b) Staff, (please write your job title in the space provided below).

JobTitle: _____

Please continue on page 6 overleaf ➜

Question 12.
How many years have you worked for ECCI?

___ years

Question 13.
Does your current job include environmental responsibilities? (Please tick as appropriate).

___Yes ___No

Question 14.
Do you support any environmental interest groups in your spare time? (Please tick as appropriate).

___Yes ___No

Please place your completed questionnaire in the self seal envelope provided and return by internal mail to **Ruth Thomas, c/o Mineral Resources,** Environmental Issues at English China Clays International – Questionnaire. Please feel free to make any additional comments you may have in the box below.

Ruth Thomas
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Email: a.r.thomas@bath.ac.uk

BLANK SPACE FOR COMMENTS

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE

Appendix iii: List of Interviewees

Environmental Management Programme		
UK Operations		
Date	**Interviewee**	**Position**
1.2.99	Mandy Gore	Environmental Scientist
1.2.99	Mark Gronow	Senior Purchaser
2.2.99	David Bell	Quality Manager
2.2.99	Paul Richards	Mines Manager
2.2.99	Malcolm Walkey	Principal Energy Consultant
3.2.99	Chris Varcoe	Senior Surveyor
3.2.99	Richard Hoare	Mines Manager
4.2.99	Nigel Kendal	Mines Manager
4.2.99	Chris Bray	Senior Purchaser
9.2.99	Jeff Harrison	Senior Manager – Wet operations
9.2.99	Bob Stidston	Ports Manager
10.2.99	Andy Bond	Mines Manager
10.2.99	Nigel Glasson & Chris Hogg	Senior Manager – Technical Services Ceramics
11.2.99	Philip Larson	Head of Mineral Resources
11.2.99	Bill Rouse	Senior Manager – Dry Operations
12.2.99	Tony Mitchell-Harris	Senior Manager - Engineering
17.2.99	Roger Preston	Director – European Operations
US Operations		
16.6.99	Robert Gilbert Greg Eckstein	Director – ESH America and Pacific ESH Leader

Environmental Product and Process Innovation Activities		
UK Research		
Date	**Interviewee**	**Position**
22.2.99	Jon Phipps	Senior Scientist
23.2.99	Richard Hexter	Senior Manager – Commercial and Special Projects
23.2.99	Des Payton	Scientist
24.2.99	John Husband	Senior Scientist
24.2.99	Roger Martin	Business Manager – European Paper Group
25.2.99	John Adams	Head of Research
25.2.99	Bob Cowling	Sales (formerly rECClaim marketing)
1.3.99	Richard Brown	Director Research and Technology
1.3.99	John Purdey	Senior Scientist
US Research		
14.6.99	Patrick Miller	Product Manager – Deposit Control Technologies
14.6.99	Ross Gray	Product Manager
15.6.99	Phil Jones	Vice President Technology
15.6.99	David Kesselica	Marketing Director
15.6.99	Ollie Toivonen	Senior Development Engineer
17.6.99	Jose Rodriquez & Kevin Snowden	Senior Development Engineers

Appendix iv: Descriptive Statistics

Variable	Mean	Standard Deviation	Skewness	Kurtosis	Reliability Cronbach's alpha
Question 3.					
Likert scale 1-5: 1= not important 5=very important					
international	2.43	1.28	0.42	-0.98	
european	2.70	1.18	0.18	-0.92	
national	3.07	1.04	-0.18	-0.62	0.82
regional	4.21	0.70	-0.83	1.22	
local	4.71	0.54	-2.03	5.91	
Question 4.					
Likert scale 1-5: 1=not important 5=very important					
tip restoration	4.24	0.90	-1.34	2.05	
pipeline burst	4.29	0.82	-1.21	1.66	
community relations	4.39	0.75	-1.35	2.31	0.59
employee safety	4.83	0.41	-2.34	4.89	
Question 6.					
Likert scale 1-5: 1=not important 5=very important					
community relations	3.78	0.98	-0.60	-0.23	
tip restoration	3.93	0.82	-0.86	1.07	0.74
pipeline burst	4.20	0.80	-0.92	0.81	
employee safety	4.39	0.78	-1.22	1.14	
Question 8.					
Likert scale 1-5: 1=strongly agree 5=strongly disagree					
statement a	1.55	0.61	0.93	1.91	
statement I	2.32	0.81	0.38	0.57	
statement c	2.34	0.72	0.46	0.31	
statement d	2.54	0.95	0.51	-0.29	0.85
statement e	2.60	0.91	0.31	-0.26	
statement h	2.63	0.87	0.34	-0.15	
statement b	3.30	0.90	-0.13	-0.40	

Variable	Mean	Standard Deviation	Skewness	Kurtosis	
Question 8 cont.					
statement g	3.31	0.89	-0.25	-0.08	
statement f	3.56	0.89	-0.54	0.34	

Variable	Mean	Standard Deviation
Question 1b.		
Ranking 1-5: 1= highest impact 5=lowest impact		
climate	0.29	1.00
cultural heritage	0.50	1.39
housing	0.99	1.79
soil	1.02	1.78
landscape	1.39	0.96
transport	1.89	1.95
human beings	1.98	1.80
habitat	2.078	1.74
water	2.27	1.86
air	2.34	1.843
Question 2.		
Ranking 1-5: 1= most interested 5=least interested		
local community	1.77	0.90
interest groups	2.12	1.00
regulator	2.44	0.90
customers	4.13	0.76
shareholders	4.51	0.79.
Question 5.		
Ranking 1-5: 1= most important 5=least important		
people	2.05	1.07
product quality	2.29	1.13
profit	3.31	1.43
environment	3.38	1.19
creativity	3.93	1.28

Question 7.		
Ranking 1-5: 1= most important 5=least important		
Variable	**Mean**	**Standard Deviation**
profit	1.50	1.01
product quality	2.14	0.79
people	3.28	1.13
environment	3.10	0.94
creativity	4.04	1.02

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